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GEORGE PERKINS CLINTON, 1867–1937

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(WITH PORTRAIT)

The coming of the white man to the great Northwest in the upper Mississippi Valley was the signal for the native Indian to again "move-on" farther west. At one time the Indians considered the British as their friends, but with the advent of the American army under Clark, the British found that politically, it was wise not to befriend the Indian any longer.

The early 1830's saw the disappearance of most of the Indians from the prairies. In northern Illinois, however, there still remained portions of the Sauk (or Sac) and Fox tribes under the leadership of Black Hawk and the Prophet that roamed the Rock River country and made annual trips to visit their friends, the British, at Malden (near Windsor, Ontario) and receive presents. As settlements began to be established in the Rock River country, Black Hawk in 1832, made his final effort to retain the country of his forefathers. The Black Hawk war was short; nevertheless several sanguinary battles were fought and Indian depredations often equalled those in early Kentucky history. Had the white man been fighting to retain his ancestral hunting grounds, would he have done any less than the Indian did?

With the end of the Black Hawk War, there was a great influx of immigrants from New England and the northern states. The Rock River country is described as typical rolling grass prairie land, with scattered groves of timber. The land was so fertile

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that an early writer describes it as being "unexhaustible." As the number of settlers increased, new counties were established. In 1836, Ogle County was organized from territory taken from the counties of Jo Daviess and La Salle, and in 1839, enlarged by taking more territory from La Salle. Oregon City was designated as county seat. It was laid out in July, 1836, and one house erected, one year later there was a total of eleven private dwellings and business houses.

The beautiful Rock River flows diagonally across Ogle County which is often described as the best watered county in the country due to the numerous springs. The prairie landscape was beautiful so that this land of flowers and trees and smut was a fitting place of birth for one of America's leading botanists.

> These are the Gardens of the Desert, these
> The unshorn fields, boundless and beautiful,
> For which the speech of England has no name—
> The Prairies. I behold them for the first,
> And my heart swells, while the dilated sight
> Takes in the encircling vastness. Lo! they stretch
> In airy undulations, far away,
> As if the ocean, in his gentliest swell,
> Stood still, with all his rounded billows fixed,
> And motionless for ever.—Motionless?—
> No—they are all unchained again. The clouds
> Sweep over with their shadows, and, beneath,
> The surface rolls and fluctuates to the eye;
> Dark hollows seem to glide along the chase
> The sunny ridges. Breezes of the south
> Who toss the golden and the flame-like flowers,
> And pass the prairie-hawk that, poised on high,
> Flaps his broad wings, yet moves not— . . .
> . . . . . .
> . . . . . From the ground
> Comes up the laugh of children, the soft voice
> Of maidens, and the sweet and solemn hymn
> Of Sabbath worshippers. The low of herds
> Blends with the rustling of the heavy grain
> Over the dark-brown furrows. All at once
> A fresher wind sweeps by, and breaks my dream,
> And I am in the wilderness alone.
>
> Bryant in "The Prairies"

Included with the pioneers that came to this primeval prairie paradise in Ogle County were the Clinton and Perkins families both from Delaware County, New York.

John Waterbury Clinton was born at Andes, Delaware County, New York. He was educated at Roxbury Academy and upon graduating went west and settled in Buffalo Grove (now a part of Polo), Ogle County, Illinois, where he taught school, succeeding John Burroughs. While engaged in teaching he married Caroline Perkins, daughter of Deacon Timothy Perkins. After their marriage the young couple moved to Forreston, Ogle County, Illinois, where they taught school for a few years and then moved back to Polo and founded and edited the Ogle County Press. John W. Clinton edited this paper for over fifty years. After his death he was voted a place in the Editorial Hall of Fame at the University of Illinois by the Illinois Press Associations in connection with the School of Journalism, for pioneer work in the Illinois newspaper field. He had helped to organize the Illinois Press Association in which organization he held several offices including that of president.

Caroline Perkins, daughter of Deacon Timothy Perkins, was born in Delhi, Delaware County, New York. She was the youngest of eight children. When she was nine months old, the family left for Illinois in a covered wagon. This young pioneer daughter received the best education available. At first she attended the Buffalo Grove school and later the Mount Morris seminary.

Under such pioneer conditions George Perkins Clinton, son of John Waterbury Clinton and Caroline Perkins, was born at Polo, Ogle County, Illinois, May 7, 1867, being the third of seven children. This embryonic botanist was always small for his age, red headed, knew what he wanted and had the perseverance to get it. His love of flowers was a natural inheritance from both his father and mother, who kept the Presbyterian Church, of which both were life-long members, supplied with seasonable flowers during their life time.

George attended the grade schools and later the Polo High School. From the first he was a good student, a willing worker, and a handy fighter (a necessary trait for a pioneer youth), as a few of the Irish of his age can testify. He helped with the chores around the house, worked in the garden, where all of the family vegetables were raised, sawed the wood, which consisted mainly of knotty oak that subscribers to his father's paper had brought in

payment of their subscriptions. In his spare time he worked in his father's press office. He was the favorite and loved one of the whole family.

In the spring of 1886, young George graduated from the Polo High School and that fall entered the College of Science of the University of Illinois at Urbana. He selected botany as his major subject and studied under the direction of that famous pioneer plant pathologist who discovered the bacterial nature of the fire blight of pears and apples, Thomas Jonathan Burrill. At this time there were about 300 students attending the University. As an under-graduate, young Clinton was a most serious student and in the summer assisted Dr. Burrill with his experimental work. Aside from the money that he could earn as a student assistant, his schooling cost the Clinton family about $200 a year. This was a large sum for a pioneer country editor to raise at a time when few subscriptions were paid in cash. As a result of his diligent work and study, the University of Illinois conferred the Bachelor of Science degree upon young Clinton in 1890 and later the Master of Science degree in 1894.

On August 9, 1892, Dr. Clinton married Anna Jane Lightbody at Pekin, Tazewell County, Illinois. Throughout their married life these two people were real chums. It was a marriage of real companionship and love. They thoroughly enjoyed the companionship of one another and both enjoyed entertaining their friends in their home. Their only son, Harry Lightbody Clinton, was born at Urbana, Illinois, on July 24, 1893.

Dr. Clinton was always held in high regard by fellow students and co-workers. Let us hear what a fellow student has to say of him. Dr. Charles Frederick Hottes, another product of Dr. Burrill, now Head of the Department of Botany and Professor of Plant Physiology, University of Illinois, writes under date of December 13, 1937:

> Dr. Clinton entered the University in '86, while I came in the following fall of '87. Both of us were interested in Botany, and since there was only one instructor, that being Professor Burrill, both of us became very intimately acquainted. Following his graduation in 1890 he was retained here as an assistant in Botany and Assistant Botanist, Experiment Station, for 10 years—namely, 1890–1900. The Experiment Station at that time was rather poor, and I am sure did not fully appreciate Clinton's worth. He worked in a basement room with a steam pipe overhead, and frequently

complained to me of the dullness he felt in consequence of the poor housing. During all this time, when I was assistant in Botany in the University proper, we had daily contact and consequently I learned a good deal of Clinton and his manner of work. As a student he was quiet and reserved in his manner, constantly at work, and was looked upon by his instructors and fellow students as a typical student. Even in those early days, he showed a great aptitude for collecting, and manifested his interest in the fungi. This, of course, was stimulated by the work of Professor Burrill and the collections of the State Laboratory of Natural History.

He was also interested in systematic phanerogamic botany and made a good many collections, some of which are now in our herbarium.

As a research worker, he forged ahead on the problem that he had chosen without consulting the literature. He did this so that he should be unbiased and reach conclusions entirely from data in hand. In one instance that I recall which was unfortunate, he spent several years culturing and investigating *Venturia*, only to find when he had gotten the method for producing the sexual stage, that it had been described by a German about a year earlier.

Professor Burrill always considered him as one of his best and most promising students.

Upon graduation in 1890, Dr. Clinton was retained at the University as assistant in botany and assistant botanist at the Illinois Agricultural Experiment Station. He was a most voluminous collector all of his life and now that he had a position he could collect to his heart's desire. At first he was interested in general botanical collecting but soon began to show a preference for the fungi.

During the World's Fair in Chicago in 1893, young Clinton had charge of the University of Illinois botanical collections. Nearby the United States Fish Commission had an exhibit and in the course of time a white "mildew-like" growth attacked some of the fish, finally causing death. This "mildew-like" growth interested young Clinton and he was assigned to investigate the cause of this fish disease. The publication of the results of this investigation was his first major scientific article entitled "Observations and experiments on *Saprolegnia* infesting fish," in Bulletin U. S. Fish Commission **13**: 163. 1894. Dr. Clinton has often told the writer how proud he was of this paper.

Our young botanist was ever alert for any kind of unusual plants as is evident by short notes in the Botanical Gazette from 1894 to 1902. During this time the following notes appeared under his name:

1. *Pleodorina* in Illinois. Bot. Gaz. **19**: 384. 1894.
2. Relationship of *Caeoma nitens* and *Puccinia Peckiana*. Bot. Gaz. **20**: 116–117. 1895.
3. *Cladochytrium Alismatis*. Bot. Gaz. **33**: 49–61. 1902. This is the first American report of this plant.

At first Dr. Clinton was inclined to specialize in the slime-molds or Myxomycetes and made a rather extensive collection. However, as an experiment station worker, it was necessary for him to think of a more economic group of fungi. From the beginning of farming, cereals were grown in Illinois and the control of smut was an economic problem. This group of fungi had been studied by Dr. Burrill while Clinton was yet a student. In 1888, Dr. Burrill published a paper "The Ustilagineae, or smuts; with a list of Illinois species." Proc. Am. Soc. Micr. **1888**: 1–13. 1888. This paper had its influence in starting Dr. Clinton to specialize in the Ustilaginales. To work with Dr. Clinton always resulted in one becoming enthused with anything that he was doing. Even small children "caught the spirit." One day his young son, Harry L., a lad of three, clasped his hands behind him and bending forward, walked as if earnestly searching for something. To the question from his father "What are you doing Harry?," the lad replied "Looking for smuts."

Dr. Clinton's interest in the Ustilaginales and his experiments on methods to control economic smuts resulted in the publication of both technical and popular articles. His first technical paper appeared in 1897 as Illinois Agricultural Bulletin 47, dealing with "Broom corn smut." Later he published a popular article "Smut enemies of the Illinois' farmers" which appeared in The Illinois Agriculturist **2**: 9–18. 1898. In 1900 he published "The smuts of Illinois agricultural plants" in Illinois Agricultural Experiment Station Bulletin 57.

Our young botanist could not spend all of his time on the smuts. The fruit growers of the state also brought their troubles to be solved. Dr. Burrill had previously served them well in his work on fire-blight of apples and pears. Now apple scab was causing trouble and the problem was given to young Clinton to solve. For several years he worked to find the perfect stage of the apple scab organism, *Fusicladium dendriticum* Wallr. In order to be abso-

lutely unbiased and to reach a conclusion based on facts at hand, Dr. Clinton always chose not to refer to any literature until he had finished a problem. He did work out original methods in the study of the apple scab fungus and in 1901 published his results in Illinois Agricultural Experiment Station Bulletin 67 "Apple scab" in which he reported that the perfect stage of *Fusicladium dendriticum* Wallr. was a *Venturia*. This bulletin is a classic in American plant pathological literature. The illustrations have never been excelled.

Unfortunately, for Dr. Clinton, it was soon found that R. Aderhold in Germany had previously been working with apple scab and had found that the perfect stage of the apple scab organism is *Venturia inaequalis*. His results had already been published four years previous as "Revision der species chlorospora, inaequalis und detricha." autorum in Hedwigia **36**: 81. 1897. To the end Dr. Clinton nearly always referred to the apple scab fungus as a *Fusicladium*.

Another classic piece of research for the Illinois fruit grower was on the fungi causing apple rots. Dr. Clinton went at solving this problem in his usual systematic, thorough manner and in 1902 published another classic bulletin, typical of the Illinois Experiment Station. In Illinois Agricultural Experiment Station Bulletin 69 he gave the fruit grower a bulletin entitled "Apple rots in Illinois." Again his genius is revealed in this well-written and well-illustrated paper.

While at Illinois, Dr. Clinton did not devote his entire time to research. Several students were fortunate to be assigned to his care. As an example of the high regard they had for their instructor let us hear what one of them has to say. Dr. Henry Allan Gleason of the New York Botanical Garden had his early botanical training under Dr. Clinton. Under date of January 12, 1938, Dr. Gleason writes:

> I was a student at the University of Illinois from 1897–1901, taking my major work in botany. During the spring of my freshman year, I wanted to get a little work on the side and found it under Dr. C. F. Hottes. The following autumn, *i.e.* September, 1898, I again applied for work and was then placed in charge of Dr. Clinton. I saw little of him for the first half of the year since my work was exclusively indexing exsiccati of fungi. That work was done on the main floor while Clinton did his work in some

unknown recess of the basement. Eventually I got caught up with the indexing, and to my delight, was moved into this same basement cubby-hole, where Clinton spent his time. I found there a low ceilinged room about the size of an ordinary laboratory, well provided with deep shelves and these shelves filled with great bundles of herbarium specimens tied up in newspapers. On the tables were stacks of drying paper and pressing paper, the pressers and big rocks for weights. The room was crowded, dusty, and secluded but it was almost a paradise for a young botanist. Next to it, and with a connecting door, was a little cubby-hole built under a stairway possibly 8 × 15 feet, and here at a table under the window sat Clinton with his microscope and papers, and various sorts of apparatus were piled up on tables behind him.

Clinton explained to me that this great accumulation of plants dated back into the early eighties when A. B. Seymour traveled widely over the whole state and accumulated thousands of specimens of fungi and flowering plants. The rusts and the powdery mildews had already been studied and published by Burrill but there were literally thousands of unidentified fungi, and thousands more of flowering plants. There was no money available to pay for the mounting of these plants so Clinton and I concluded a bargain, that I was to do the mounting in return for my choice of the duplicates to add to my private herbarium.

This was really my first introduction into the usual experiences of a botanist's life. I learned to know that there were many other botanists besides those in the university faculty. I learned a good deal of their activities and problems, and more or less of the methods which they used. From Clinton himself, I got my first insight into botanical research. Three or four times a day he would call out from his cubby-hole "Gleason come here." I would sit down on a chair beside him and for an hour or so he would pour out into my ears the story of all the perplexities and difficulties which he was finding in his research.

Unconsciously he taught me a great deal of botany, and even more in the following year when he invited me to join in a class of advanced systematic botany. He showed me how to identify grasses and sedges, and taught me not to be afraid of the small inconspicuous flowers of weeds. All in all, the knowledge and especially the inspiration which I received from Clinton was very great, and at the present time is of far greater significance to me than all I learned in the formal classes of botany.

Clinton's son, then a six year old boy, but later killed in the World War, used to come into the room every now and then to visit his father. When tired of his questions Clinton would tell him to sit on a certain chair and keep quiet. I remember once that Harry jumped off the chair, ran to his father and asked if he could get down now. His father replied, "No, you sit still in that chair and the longer you sit there the sooner I will let you get down."

I was not the only person by any means who was benefited by contact with Clinton during these years. There were several others whom he befriended in the same way, and he also had the happy idea of inviting botany students to his own home, a thing which few of the professors ever did.

After ten years work at the Illinois Agricultural Station, Dr. Clinton desired more training in mycology and accordingly, in 1901 he applied to Harvard University for admission to the botany department then under the supervision of Dr. W. G. Farlow and Dr. Roland Thaxter, America's two leading mycology teachers of this period. In making arrangements to enter Harvard University, Dr. Clinton decided to go to Cambridge and at the same time see as much of the eastern United States as possible. Accordingly in the early part of the summer of 1900, he and two companions left Urbana, Illinois, on bicycles enroute to Cambridge, Massachusetts. On their way east they visited Washington, D. C., Baltimore, New York and other intermediate places of interest.

Dr. Clinton was granted a Thayer Scholarship which scholarship is " to pay the income thereof (trust fund) to the ten most meritorious scholars in Harvard University who may actually need the same." He secured a leave-of-absence from Illinois and entered Harvard University in the fall of 1900, and in 1901 was granted the degree of Master of Science, in 1902 Harvard University conferred upon him the Doctorate of Science. His thesis was the " North American Ustilagineae " which was published as contribution No. 57 from the Cryptogamic Laboratory of Harvard University.

Upon graduation, he was recommended for a position of botanist at the Connecticut Agricultural Experiment Station in New Haven, and received this appointment. He resigned his position in Illinois and assumed his duties in Connecticut July 1, 1902. He always retained the simple title of " botanist."

Soon after leaving Cambridge, Harvard University sent him to Puerto Rico to discover if a recently imported coffee rust had spread to the native trees. He found no signs and left at the end of a month, but during that time he collected about a thousand specimens of miscellaneous fungi, among them only a few smuts. Again in 1908, Harvard University sent him to Japan to bring to this country parasites for controlling the gypsy moth.

As station botanist in Connecticut, he successfully solved many plant disease problems for the farmers. His annual reports are veritable plant disease encyclopedias. Each year he reported the fungi new to Connecticut, new or unusual plant injuries besides

reporting the prevalence of disease on the various crops in the state. He also reported the results of his scientific researches. As examples of the many problems investigated the following is a brief list taken at random from his reports:

1904—Downy mildew, or blight of musk melons and cucumbers caused by *Peronoplasmopara cubensis* (B. & C.) Clinton.
also:
Downy mildew, or blight of potatoes, caused by *Phytophthora infestans* (Mont.) DeBy.
1905—Downy mildew of lima beans caused by *Phytophthora Phaseoli* Thaxter.
1906—Dry rot fungus, *Merulius lacrymans* (Wulf) Schum.
1907—Heteroecious rusts of Connecticut having a *Peridermium* for their aecial stage.
1909—Peach yellows and so-called yellows.
1910—Oöspores of potato blight, *Phytophthora infestans.*
1912—Chestnut bark disease caused by *Endothia gyrosa* var. *parasitica* (Murr.) Clinton.
1914—Chlorosis of plants with special reference to calico of tobacco.

Of the bulletins issued by Dr. Clinton and associates, typical examples are those dealing with "Wildfire of tobacco in Connecticut" (Bull. 239), "The willow scab fungus—*Fusicladium saliciperdium*" (Bull. 302), and "Dutch elm disease" (Bull. 389).

Dr. Clinton was a pioneer in developing methods of control for the late blight of potato. He conducted some of the earliest spraying experiments in the United States for the control of this destructive potato disease. The first potato spray outfit in America was built at the Connecticut Agricultural Experiment Station by Dr. Roland Thaxter, who preceded Dr. Clinton as botanist. An old time wash-boiler was used as the spray tank of this pioneer sprayer. The original is now preserved in the Botany Department. These spraying experiments were continued by Dr. William C. Sturgis and later by Dr. Clinton and have resulted in protecting potatoes from late blight through the blight area in America, resulting in the saving of millions of dollars to American potato growers.

In 1919, the General Assembly of the State of Connecticut established the "Tree Protection Examining Board of Connecticut." Dr. Clinton was selected as botanist for this board, being associated with Dr. W. E. Britton as Entomologist and W. O. Filley as Forester. Everyone in the state doing tree surgery or tree

pruning must secure a permit by examination from this board. Previously, Dr. Clinton was State Botanist of the Connecticut State Department of Agriculture.

Dr. Clinton was very loyal to the various farm organizations and regularly met with them in the capacity of an adviser on the control of plant diseases. He was a member of the Connecticut Pomological Society, Connecticut Forestry Association and the Connecticut Vegetable Growers Association. He was respected by Connecticut farmers who constantly consulted him concerning their plant disease problems. In 1935, "Honorary Recognition" as a leader in agriculture and rural life was awarded him by the Connecticut State College at Storrs.

For fourteen years he was associated with the botany faculty of Yale University. From 1915 to 1926 he was lecturer in forest pathology and from 1926 to 1929, Research Associate in Botany and gave instruction in plant pathology.

In the field of science, none excelled him and few equalled him. His contemporaries seldom questioned his results; on the other hand they frequently went to him for advice and usually respected his opinion. In his work he was decidedly an individualist. He was slow to express an opinion but once expressed he held to it most tenaciously until enough evidence was produced to prove that he was in error, which seldom happened. It was always his ambition to attend as many scientific meetings as possible, on these occasions he was usually accompanied by his wife, but not to deliver lengthy, bombastic reports since he rendered his best service to science quietly in the committee room where his advice was frequently sought.

He was a member of a rather large number of scientific societies, such as The Connecticut Botanical Society, The New England Botanical Club, Botanical Society of America, American Phytopathological Society, of which he was president in 1912, American Society of Plant Pathologists, Sigma Xi, Fellow American Academy of Arts and Sciences, Fellow American Association for the Advancement of Science, of which he was vice-president of section G in 1914, the Mycological Society of America, and finally he was honored in 1930 by being elected a member of the National Academy of Science.

It was the great privilege of the writer to study under Dr. Clinton at Yale University and also to work with him in the study of the Ustilaginales. As we sat side by side, day after day, his thorough training became more evident. Dr. Clinton had the knowledge of a dozen modern trained specialists but due to his modesty, this was concealed to all except those closely associated with him. He always had high regard for his teachers. Scarcely a day passed but he related some incident of his school days and told what Burrill, or Farlow, or Thaxter did under various circumstances, and in many ways tried to emulate his dearly beloved teachers.

As a teacher, he did not follow modern psychology book methods. Rather, he taught his students how to observe nature in the field and make their own conclusions. As winter approached, he reluctantly gave up field collecting trips and confined his efforts to the class room. He was inspiring and original as a teacher and enjoyed the company of his students and in turn every student enjoyed working with him and, without exception, held their teacher in highest respect.

As a man, he was possessed of many fine qualities of character that his natural modesty and unassuming manner concealed from all but his more intimate friends and associates. He was sincere, loyal, broad-minded and very democratic. Instances of his generosity appear in unexpected places, unobtrusive acts of kindness and sympathy were his habit.

He was fond of travel and during these trips he always collected fungi profusely. His vacation trips took him to various parts of the United States and Canada and also to Europe and South America. He was nearly always accompanied by his life partner, Mrs. Clinton.

During the World War, his only son, Harry Lightbody Clinton, served in Company C, 58th Infantry of the 4th Division of the U. S. Expeditionary Army in France. On July 24, 1918, he was killed at Brieulles-sur-Meuse, France. A report that he was missing reached the grief stricken parents at Thanksgiving time and his death was confirmed in an official notice on New Year's eve.

Dr. Clinton was a Deacon in the Westville Congregational Church under the pastorate of Rev. J. Edward Newton. He was

always loyal to this organization and often gave financial help when others better able to help, declined. He was beloved by his neighbors in the Westville section of New Haven and enjoyed their company. He and his wife were members of the Edgewood Club, a neighborhood social organization.

This busy worker reluctantly retired as Station Botanist July 1, 1937, after over 47 years of active service in Illinois and Connecticut; however, he remained on the station staff in the capacity of Consulting Botanist. While he officially retired, this man accustomed to always be working, really never stopped work and on August 13, 1937, he departed this life at his residence, 77 Barnett Street, 44 days after retirement. He is interred in the Evergreen Cemetery, New Haven, Connecticut, by the side of his only son.

This busy man had work planned that would have taken many years to finish. He could always find many unsolved problems to solve on his trips through forest and field.

> To him who in the love of nature holds
> Communion with her visible forms, she speaks
> A various language; for his gayer hours
> She has a voice of gladness, and a smile
> And eloquence of beauty, and she glides
> Into his darker musings, with a mild
> And healing sympathy, ere he is aware. . . . .
> . . . . . .
> . . . . . As the long train
> of ages glide away, the sons of men,
> The youth in life's green spring, and he who goes
> In the full strength of years, matron, and maid,
> And the sweet baby, and the gray-headed man,
> Shall one by one be gathered to thy side,
> By those, who in their turn shall follow them.
> So live, that when thy summons comes to join
> The innumerable caravan, that moves
> To that mysterious realm, where each shall take
> His chamber in the silent halls of death,
> Thou go not, like the quarry-slave at night,
> Scourged to his dungeon, but sustained and soothed
> By an unfaltering trust, approach thy grave,
> Like one who wraps the drapery of his couch
> About him, and lies down to pleasant dreams.
>
> Bryant in "Thanatopsis"

THE PENNSYLVANIA STATE COLLEGE,
DEPARTMENT OF BOTANY

[1] OBSERVATIONS [2] ON THYRONECTRIA DENIGRATA

CATHARINE LIENEMAN

(WITH 47 FIGURES)

Thyronectria denigrata (Wint.) Seaver,[3] a Hypocreaceous fungus, occurring on branches and fallen trunks of *Gleditschia triacanthos* L. (FIG. 1) in the eastern and central United States, consists of an internal mycelium producing subimmersed or erumpent-superficial, pulvinate, orange-brown stromata. On or near the surfaces of such stromata are formed dense cespitose, carnose-membranaceous, subglobose, ostiolate, reddish-brown to black perithecia (FIG. 2, 3, 4). The cylindrical, short stipitate asci contain eight hyaline or slightly yellowish short elliptical ascospores which are three to five septate, muriform, more or less constricted at the septa and 10–16 × 7–10 μ.

This study is based on numerous collections made intermittently in the flood-plain areas around Lincoln, Nebraska, since 1930. Early collections were the source of eighteen monascospore cultures. Slides were made from naturally developed infections and from inoculated materials.

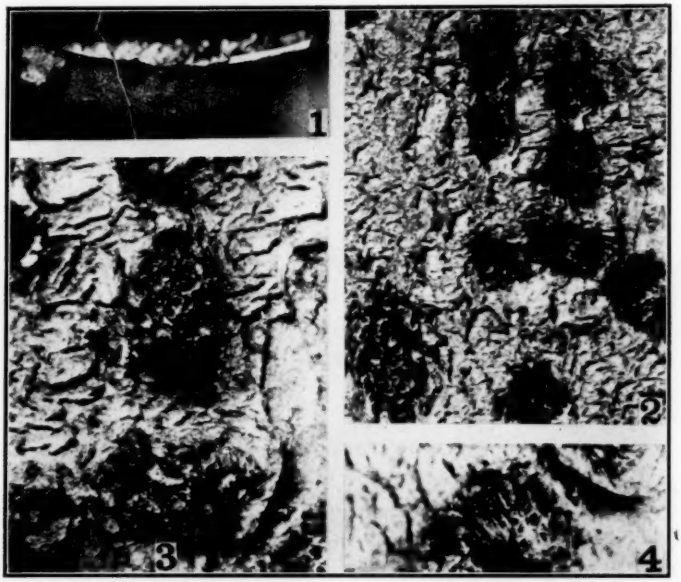
The best slides were obtained with materials fixed in formal-acetic-alcohol, cleared in cedar oil, sectioned at three to six microns, stained with Haidenhain's haematoxylin and counterstained with Orange G. Agar film growth was stained with methyl blue in lactophenol. Zeiss apochromatic lenses have been used in the major part of the microscopic study; sketches have been made with the camera lucida.

[1] Contributions from the Department of Botany, University of Nebraska. N. S. No. 107.

[2] A section of a thesis submitted in partial fulfillment of the degree of Doctor of Philosophy in the Graduate School of the University of Nebraska.

[3] Seaver, F. J. (Mycologia **1**: 203–206. 1909) regards *Pleonectria* Sacc. (Nuov. Giorn. Bot. Ital. **8**: 178. 1876) as synonymous with *Thyronectria* Sacc. (Grevillea **4**: 21. 1875).

The youngest stromata, whether found in nature or on inoculated twigs or agar, are small, soft, fleshy, pale yellow, pseudoparenchymatous masses arising from the hyphae of the substratum. The outer surface of the stroma is slightly leathery and darker with more compact cells than the interior. The hyphae, apparently uninucleate, vary from the usual three or four microns in diameter to an occasional nine. In branches with bark, the stromata form under the lenticels and later emerge through



FIGS. 1–4. *Thyronectria denigrata* on *Gleditschia triacanthos*.

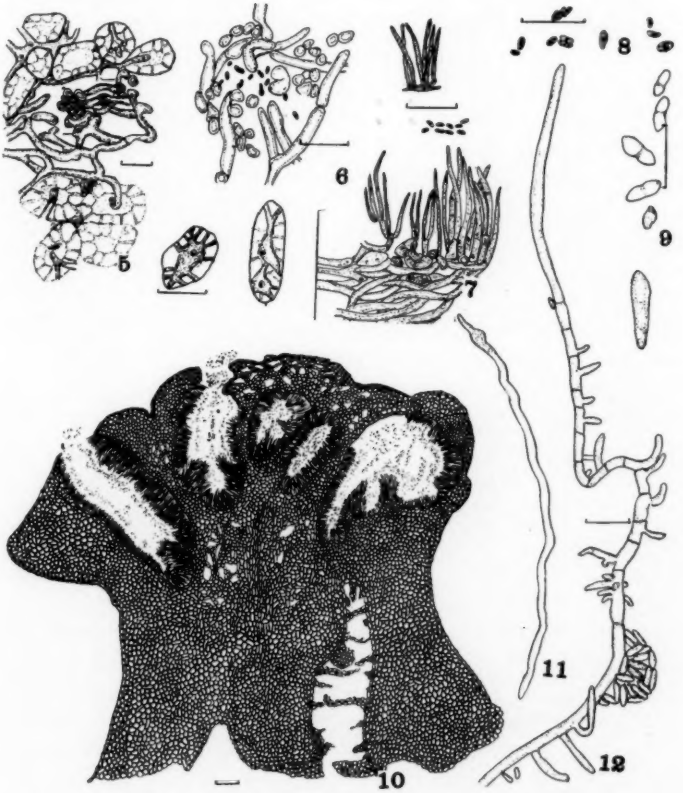
them; on partially or wholly decorticated branches or split branches, they usually emerge through the ray cells and remain much smaller in size, often bearing only one perithecium. Druses from crystal bearing cells of *Gleditschia* are sometimes embedded in a stroma. Cortical sclerenchymatous cells of *Gleditschia* occur in almost every stroma, either as isolated or as compact masses, surrounded by fungus hyphae or sometimes penetrated by hyphae (FIG. 5). Parenchyma regions are obliterated and replaced with knots of

fungus hyphae usually three microns in diameter. In cultures, the hyphae which penetrate the agar are somewhat narrower (2 μ) and more loosely arranged. Stromata on twigs enlarge until the lenticel opening is completely filled and the periderm is forced back. The largest stromata seen were about two mm. thick and three by five mm. in extent.

At the period of emergence, stromata show conidial formation in one of two ways. The simpler and less common method is the local abstriction of exogenous spores from the stromatic hyphae (FIG. 6). The regular method involves the formation of slender, tapering conidiophores, usually one micron in width, which abstrict conidia from their apices (FIG. 7). In some agar cultures (FIG. 18) dense tufts of such conidiophores occur as surface mats, in others they line shallow open pockets which are similar to acervuli, or deep closed stromatic pockets, similar to pycnidia (FIG. 20). In natural or induced lesions on twigs, the conidia are typically formed in pycnidium-like areas. The conidiophores may be of rather uniform height, non-septate, unbranched, somewhat tapering, with an affinity for the crystal violet of the triple stain (FIG. 7 above), or they may be of irregular height, septate, and verticillately branched (FIG. 18). Both types may occur within the same stroma, and within the same conidial cavities (FIG. 10). Many of the pycnidium-like structures are compound to an amazing extent. A single cross-section of *Thyronectria denigrata* taken from agar cultures showed fifty-nine such locules developed on one stroma. The color of the pycnidium-like bodies on agar varies from "cinnamon," "clay color," or "onion skin pink" (Ridgway), to reddish-brown or black in nature.

The abundant conidia formed by these conidiophores are minute (.6–1 $\mu \times$ 1.8–3 μ), elliptical, hyaline, thin-walled cells characterized by a relatively large nucleus and scanty cytoplasm and a tendency to cohere in groups (FIG. 8, 17). In a dry atmosphere, the conidia are often massed together to form curling, waxy, orange spore horns which break down into a milky mass on contact with moisture, whereupon the component conidia quickly swell. The conidia germinate with great readiness, showing vacuole formation, increase in size, and hyphal formation in a few hours (FIG. 9, 11, 12). Such hyphae in turn produce other conidia on short

lateral or apical protuberances. This cycle of conidia, hyphae, secondary conidia may be repeated many times. No conidial or hyphal fusions occur at first; later fusions, particularly of the H-type are numerous within the clone. Coils of hyphae which



FIGS. 5–12. *Thyronectria denigrata* mycelium, pycnidia, conidiophores, and conidia.

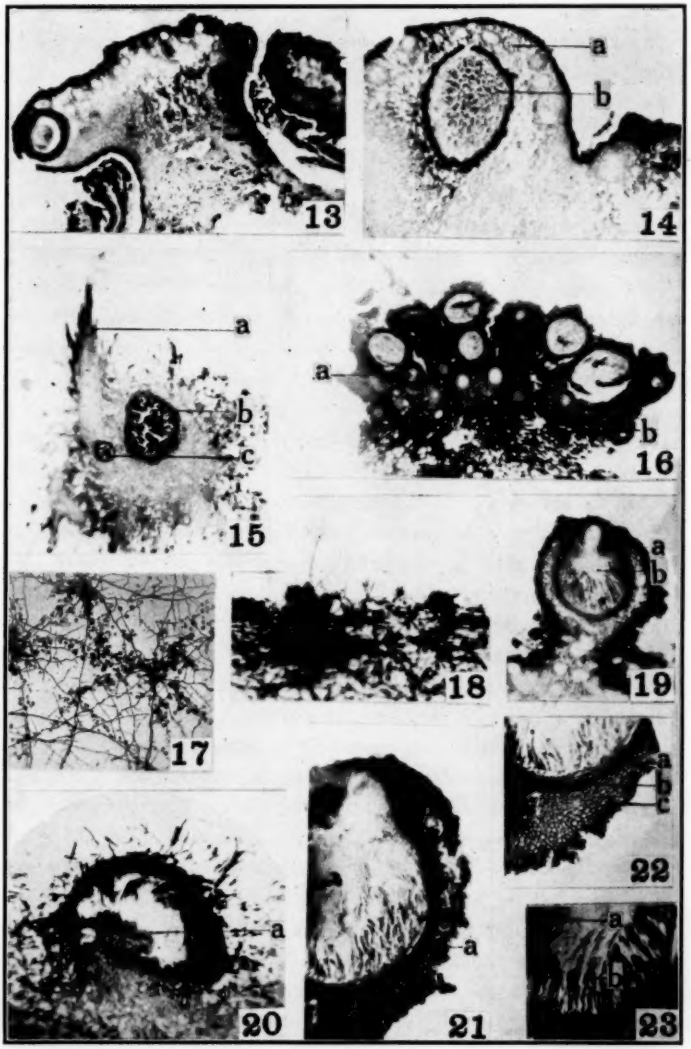
show both fusions and conidial formation are often seen on agar film growth. The fusions appear to be nutritive rather than sexual. The viability of the conidia while massed together is remarkable. Almost perfect germination resulted when spore horn and "pycnidial" material was used after more than five

months of exposure to drying. Momentary immersion of a twig bearing conidial material in pycnidium-like structures results in immediate extrusion of conidia in milky masses from the irregular surface openings.

Sections of certain young stromata outwardly indistinguishable from the young stromata already described, show numerous specialized peripheral areas consisting of larger hyphae coiled at least two turns, but often intricately twisted, surrounded by more compactly arranged hyphae than those of the stroma in which they are embedded (FIG. 13, 14*a*). The entire primordium constitutes a small spherical mass of closely interwoven hyphae with the coil at the center. Each cell of the coil is multinucleate and filled with dense cytoplasm (FIG. 24). Nuclei stain vividly. These primordia occur when conidial formation is at its height or past it, and previous to the formation of recognizable perithecia or more rarely as an accompaniment to perithecial formation. They are interpreted as being Woronin hyphae. No trichogyne has been observed.

Since a complete developmental series could not be followed in previously fixed material, in the autumn of 1935 stromatic material of *Thyronectria denigrata* was fixed at weekly intervals. More than a thousand slides have been made and studied in an effort to follow the behavior of the Woronin hyphae and the details of perithecial development, but the results have been disappointing. The incompleteness of the series obtained may, perhaps, be due to extremely short duration of the stages sought, or to the effect of excessive summer temperatures and drought, which served as a severe check to the numbers of perithecia which were produced. Since a single section of a stroma may show thirty or forty coils of varying ages, and since innumerable stromata occur on a log such as was the source of this material (FIG. 1), it would seem that the adverse weather conditions of recent summers during which this fungus was observed may be a more likely cause of failure.

Young perithecia often appear with the pycnidium-like structures and for a time externally resemble them in size, shape, and color. A simple diagnostic test which has proved helpful in distinguishing them is momentary immersion in water and then ex-



FIGS. 13–23. *Thyronectria denigrata* mycelium, stromata, pycnidia, and perithecia.

posure to air. Only the pycnidium-like areas will show the milky exudate due to numerous conidia floating about in the water. As the perithecia develop, they become uniformly globular in shape and ostiolate. Frequently their walls are roughened. In contrast, the pycnidium-like structures are variable in size and shape due to coalescence, and open through irregular apertures. There seems to be no confirmed order of perithecial formation from center of stroma to periphery or vice versa though the photographs (FIG. 3 center, 4) show peripheral perithecia surrounding emptied "pycnidia." Both sequences occur and one may find young perithecia erumpent on the same stroma which bears both disintegrating and collapsed perithecia. Both "pycnidia" and perithecia may form dense cespitose clusters. Figure 16 shows a cross-section through a small perithecial cluster and shows stages of perithecial development from the perithecial initials at the center to maturing perithecia at the periphery.

On being sectioned or incised, a young perithecium shows a central chamber which is filled with a network of turgid, septate, uninucleate, hyaline hyphae, *i.e.*, paraphyses which branch and anastomose freely (FIG. 25, 26, 27). At the base and sides of the perithecium these are attached to a small pad of thin-walled isodiametric cells. If a fresh perithecium at this stage is crushed, the contents emerge as a unit and the larger, lightly colored isodiametric cells which enclose it as a perithecial wall remain intact and separate from the surrounding stromatic material. As the perithecium matures the central cavity is enlarged and filled with a hyphal network whose cells become increasingly vacuolate and attenuate. This network of paraphyses—sensu Miller (**7**) and Nannfeldt (**8**)—is surrounded by a gelatinous matrix. The isodiametric cells of the perithecial wall become stretched and differentiated. Eventually the paraphyses break down, first among the developing asci, and then apparently progressively toward the ostiole. A delicate inner sheath constitutes the inner wall of the true perithecium (FIG. 21*a*, 26, 28); next to this is a series, usually two to six layers, of radially flattened cells, which in section appear tile like and become increasingly thick-walled (FIG. 22*a*); then follows thick-walled, compact, isodiametric, much darkened cells

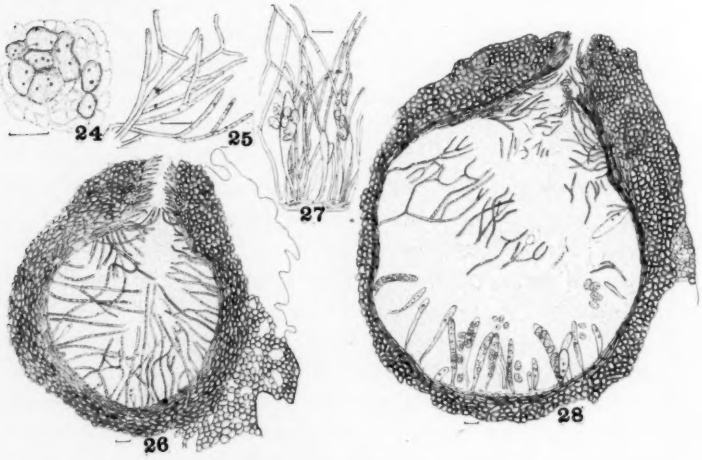
(FIG. 22*b*) which merge imperceptibly with the thick-walled, pale stromatic cells of which they are a specialized part (FIG. 22*c*). Short filiform periphyses, outgrowths of basal cells in the ostiolar wall which are oriented toward the future opening, or at right angles to the neck, fill the ostiolar area (FIG. 19*a*, 26, 28). Among the paraphyses ascogenous hyphae and asci with densely granular cytoplasm and darkly staining nuclei begin their development (FIG. 23, 26, 27, 28). The asci seem to arise from delicate uninucleate flattened cells at the base of the perithecium. The development of croziers, asci, and ascospores is in general like that commonly described for Ascomycetes (FIG. 29 through 41). As the asci mature they are typically eight-spored. In certain collections made during drought years, the asci show variations. Often some nuclei fail to develop into spores or do so very tardily. Two such abnormal asci are shown in figures 42 and 43. The ascus wall is thin and apparently elastic since it often is constricted at tip and between spores and follows the contours of the ascospore mass. Eventually the wall of the ascus disappears entirely.

The ascospores germinate freely on many culture media at room temperature, usually producing three to six germination tubes from as many cells of the ascospore. These germination tubes develop into a complex mass of septate hyphae which begin conidial formation two days after ascospores are placed on agar. Conidial formation is acroplurogenous from very short lateral or apical protuberances of hyphae. In older perithecia, the ascospores still remaining inside the perithecium may show various stages of budding or germination (FIG. 44, 45). By budding, ascospores apparently give rise to the conidia which are often found within the matured perithecia. Chance observations of germination of ascospores within asci of *Thyronectria denigrata* lead to the speculation as to the possibility that *T. denigrata* and *T. sphaerospora* (Ellis & Ev.) Seaver represent the same fungus affected by different environmental conditions. The following points seem to confirm this:

1. Twigs with typical *Thyronectria denigrata* perithecia and smooth ascospores wrapped in wet paper towels and placed in a moist chamber for two days, show five to eight per cent budding

ascospores and a few germinating ascospores. Field collections often show a small per cent of budding ascospores. One hundred per cent budding and germination occurs in maturing *Thyronectria denigrata* asci teased out of the perithecium and held in a moist chamber overnight (FIG. 46).

2. To the author's knowledge, the only recent collections of *T. sphaerospora* made at Lincoln, Nebraska, the type locality, were made in September 1932 and November 1932, the former by the author who mistook the material for *Thyronectria denigrata* until



FIGS. 24–28. Details of perithecia of *Thyronectria denigrata*.

a microscopic examination was made; the latter by Dr. Leva B. Walker. No normal matured specimen of *Thyronectria denigrata*, the object of the search, was found during the autumn of 1932 though this fungus is usually abundant.

3. The early collections which are recorded for Lincoln, Nebraska were made in November 1888 and September 1889.

4. A check with weather records in all four cases reveals that collections of *Thyronectria sphaerospora* were made during months of less than normal rainfall and somewhat lower temperatures preceded by summer months of abundant rainfall.

	1888		1889		1932		Average for 50 yrs.	
	Temp.	Rainfall	T.	R.	T.	R.	T.	R.
Apr.	54	1.61	54	2.28	55	1.20	51.9	2.39
May	57	4.62	61	2.70	65	2.82	61.8	3.93
June	70	4.74	69	2.63	73	4.46	71.9	4.13
July	78	3.00	73	5.16	80	5.68	77.4	3.76
August	72	4.95	72	4.40	76	4.36	75.1	3.48
Sept.	64	0.08	63	1.60	65	1.83	67.2	2.97
Oct.	50	1.84	51	0.38	52	1.58	54.7	1.88
Nov.	38	0.19	35	0.85	38	0.04	39.9	1.21

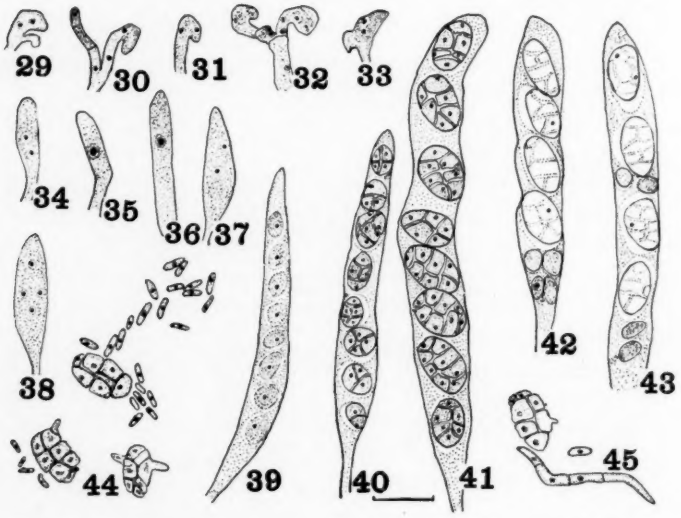
A similar check of weather records and collections of *Thyronectria denigrata* made in Nebraska and deposited in the herbarium of the University of Nebraska shows this fungus was found when rainfall was close to the fifty year average.

5. A comparison of cultures derived from ascospores of both species shows striking parallels in germination, early conidial formation, and rate of growth. The early stages studied were on agar film. A contrast of later development cannot be made, because no monascospore isolations of *T. sphaerospora* for stock cultures were immediately made. Apparently the viability of *T. sphaerospora* is limited, for attempts to obtain stock cultures after two months were futile.

6. A comparison of descriptions of characteristics of the two species as described shows the following parallelism: (*a*) host—*Gleditschia triacanthos,* though one collection of *Thyronectria sphaerospora* is reported on twigs of *Fraxinus viridis?* (*b*) general habit and appearance of stromata and perithecia except for a smaller number of perithecia in *T. sphaerospora.* The points of contrast are: (*a*) ascospores of *T. sphaerospora* are $5 \times 8\,\mu$ and three septate, those of *T. denigrata* are $10\text{–}16 \times 7\text{–}10\,\mu$ and three to five septate; (*b*) asci are clavate in *T. sphaerospora* and briefly stipitate in *T. denigrata;* (*c*) the ascospore of *Thyronectria sphaerospora,* unlike that of *T. denigrata,* is surrounded by "numerous spore like bodies which appear like minute appendages."[3] However, the author's collections of *T. sphaerospora* showed clusters of as many as twenty perithecia; whereas young material of *T. denigrata* occasionally shows considerably fewer perithecia. On

[3] Seaver, F. J. Mycologia 1: 206. 1909.

split twigs, *T. denigrata* may produce uniloculate stromatic material. Therefore, the number of perithecia on a stroma is not deemed a valid distinction. Moreover, young ascospores of *T. sphaerospora* showed no appendages but were identical with those of *T. denigrata.* Figure 47 of *T. sphaerospora* shows the occasional smooth ascospore and also some with a greater number of septations. Perithecial material of *T. denigrata* held in a moist



FIGS. 29–45. Ascus and ascospore development in *Thyronectria denigrata.*

chamber in its early germination simulates that of *T. sphaerospora* (FIG. 46). The spore-like bodies mentioned for *T. sphaerospora* are the exact equivalent in size of the conidia of *T. denigrata.*

These observations suggest that in the case of *T. sphaerospora,* abundant moisture induced early germination of ascospores within the asci and that later a subnormal rainfall served as a check to the breakdown into conidia, or the further germination of the ascospores.

The formation of conidia just prior to, or simultaneously with that of the coiled Woronin hyphae, as well as their structure,

suggested a spermatial rôle in addition to their vegetative one. Furthermore, the occasional much elongated upright hyphal columns in young cultures (FIG. 15*a*) were thought of as possible receptive hyphae. Therefore, tests for possible sexuality of *T. denigrata* were made as follows:

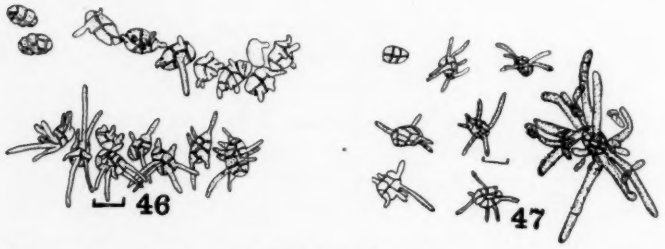
1. Cultures derived from eighteen monascospore isolations were used in all possible combinations of selfs and crosses on Difco potato dextrose agar. As the clones approached each other, growth was sharply checked, resulting in a clear line of demarcation, without discoloration, cracking, or drying up of agar, or heaping up of stromatic mycelium just back of the clear zone. This was the case regardless of the source of the material. All clones produced abundant and often compound pycnidium-like structures with conidia in spore horns. After four months, perithecial development was consummated on one petri dish on which cultures b and f [4] had been planted. Culture f showed immature perithecia with paraphyses; culture b had one maturing perithecium, covered with a few hairs, with asci containing immature ascospores approximately two-thirds normal size ($5.5–7 \times 7–10.5\ \mu$). The line of demarcation between clones was similar to that of the others, so that obviously no mycelial fusion had effected a sexual stimulus. Similar cultures have since been tried repeatedly without perithecial formation.

2. The structure and abundance of conidia and the ease with which they can be carried by insects or water suggested an association of conidia and vector, particularly since the fungus has a pleasant fragrance and exudes a clear liquid. Field observations show nematodes very actively moving about the "pycnidial" masses. Insects of various sorts are occasionally seen. When *Drosophila melanogaster* were introduced at various intervals into flasks of potato dextrose agar inoculated with cultures representing nine monascospore strains, the flies were not attracted by odor or ooze. The effectiveness of flies for conidial transfer was demonstrated when one fly was removed from these cultures and introduced momentarily into a flask of sterile cornmeal agar whereupon eighty to one hundred clones developed. In spite of the carriage

[4] These cultures have been deposited with the Centraal Bureau voor Schimmel Cultures, Baarn, Holland.

of conidia from one clone to another possibly compatible with it, no perithecia were ever formed. Sterile distilled water introduced at intervals into similar cultures also served only to move the conidia to new areas where they germinated to form new clones, provided the agar was not already occupied.

3. Spore horns removed with sterile needles were placed in sterile distilled water and the conidial material was placed on the mycelium, and on young stromata and inside young locules and on the columnar structures which suggested receptive structures to effect possible "spermatization" or "conidiation" such as a number of investigators have recently reported. No perithecia were obtained.



FIGS. 46, 47. Ascospores of *Thyronectria denigrata* and *T. sphaerospora* contrasted.

4. "The antagonism" or clear zones between clones was interpreted as due possibly to staling products or to reduced nutrition. Replacement segments were tried. In petri dishes, three areas the size of a typewritten "o" were removed from each clone which had attained the size of a quarter and replaced with others from different clones. The original colony was uninfluenced.

The author concludes the conidia function only vegatatively.

The adaptability of *Thyronectria denigrata* to various woody stems was demonstrated by introducing inoculum consisting of mycelium on agar to detached living *Gleditschia* twigs, decorticated *Gleditschia* twigs, and dead twigs, and to substrata foreign to this species, such as twigs of living *Ribes*—dead *Ribes* is host for *T. berolinensis* (Sacc.) Seaver—dead and living twigs of *Carya alba,* host for *T. missouriensis* (Ellis & Ev.) Seaver, twigs

of *Fraxinus,* one of the questioned hosts for *T. sphaerospora,* and twigs of *Quercus macrocarpa,* and fragments of a log of *Salix,* all of which had been surface sterilized and placed in Erlenmeyer flasks loosely stoppered with cotton. In all cases, mycelium established itself and produced conidia in pycnidium-like structures, albeit their number was much reduced on *Salix* and *Quercus* and most abundant on *Gleditschia* and *Fraxinus.* Conditions such as size of twig, moisture content, etc., necessarily varied somewhat in these cultures, so no comparison of numbers occurring is tabulated. However, moisture appears to be a critical factor. On each addition of sterile water, masses of verticillate hyphae, sometimes large enough to be visible to the naked eye, become abundant. An immediate renewal of conidia also occurred. Clear droplets exuded from some "pycnidial" areas. No perithecia with ascospores were ever found though some of the most vigorous cultures, inoculated with strains b and f singly and together, were held for two years, with occasional additions of sterile distilled water. Stromata, "pycnidial" structures, conidia in spore horns resembled those found in nature. These conidia spread the fungus to other areas of the twig and to fresh twigs each time additional moisture was added. Occasionally small perithecia like bodies were formed, but these remained abortive.

DISCUSSION

The rapidly growing literature concerning sexuality, morphology, and relationships in the Ascomycetes is notable for its extent and variations in interpretation. Only such papers as are strikingly in accord or at variance with these observations will be noted here.

The sexual rôle of microconidia, spermatia, and oidia in Ascomycetes has been ably investigated by Dodge (**3**), Drayton (**5**), Ames (**2**), Dowding (**4**), and others. While the conidia which occur in *Thyronectria denigrata* suggest a similar sexual function, a series of experiments, some carried out as nearly as possible as those reported by these workers, have shown only a vegetative function. Young cultures have been used and conidia have been introduced on various areas and at short intervals, without any

indication of sexual function or importance of sexual strains for *T. denigrata.*

The development and structure of *Thyronectria denigrata* closely follows the pattern which Miller (**7**) describes for the Sphaeriales. It shows a "Diaportheen centrum" and a thin membranaceous perithecial wall which differs from its surrounding stromatic casing in appearance and origin. It possesses a concave hymenial layer from which paraphyses and asci arise, and an ostiole of the schizogenous type lined with periphyses. The paraphyses are numerous, cellular, strongly gelatinizing, in part at least, free above, and therefore constitute the pseudoparaphyses of Petrak (**9**) and the paraphyses of Nannfeldt (**8**) and Miller (**7**). Their anastomoses and type of branching are unlike those usually illustrated, however.

Sollmann (**10**) illustrates germination of ascospores in the ascus of undoubted *Thyronectria,* designated as *Nectria Lamyi* de Notaris or *Sphaeria Lamyi* Desmaz., though his interpretation of the phenomenon is very different. Elliott and Chance (**6**) describe conidia arising from ascospores of a Discomycete, *Pezicula eucrita,* which are essentially like those seen for *Thyronectria denigrata.*

The study of the Woronin hyphae and the perithecial primordium in *Thyronectria denigrata* shows certain similarities with numerous accounts of Ascomycete development in the following respects. The primordia of the perithecia are small compact spherical bodies lying in the looser stroma near the periphery. The closely woven hyphae constituting these spheres contain at their center a coil of multinucleate cells with very granular cytoplasm which are thin-walled and of greater diameter than surrounding cells. No trichogyne nor evidence of fusion of oögonium nor antheridium has been seen. The variety of shape, size, and relationship of component cells has led the author to defer interpretation, especially since drought conditions have apparently shown so strongly their impress on this fungus. The mazes of communicating chambers described and illustrated by Allen (**1**) has a striking resemblance to those seen in *T. denigrata.*

As Wehmeyer (**11**) has pointed out, perithecia are very difficult to obtain in agar cultures, especially in stromatic forms though the

imperfect stage is obtainable on both agar and twig cultures. This is true of *Thyronectria.*

SUMMARY

Thyronectria denigrata, on *Gleditschia,* has been described from the standpoint of certain features of its morphology and development. The validity of *T. sphaerospora* as a distinct species has been questioned.

ACKNOWLEDGEMENTS

The author wishes to express her deep appreciation for the continued guidance and counsel of Dr. Leva B. Walker throughout this investigation.

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EXPLANATION OF FIGURES

FIG. 1. Lesions on log of *Gleditschia triacanthos* caused by *Thyronectria denigrata* (Ellis & Ev.) Seaver. A ruler six inches long serves as a scale.

FIG. 2. Perithecial clusters of *Thyronectria denigrata* on bark (approximately 4 ×). Photographs for fig. 2, 3, 4 by Mr. Richard Huffnagel.

FIG. 3. Perithecial cluster at upper center shows a few newly formed peripheral perithecia and some collapsed "pycnidia." The young perithecia

show the papillae and rough perithecial walls. The lower groups consist of young perithecia only (about 8 ×).

FIG. 4. Young perithecia above; empty "pycnidial" chambers below (about 8 ×).

FIG. 5. Cross-section of sclerenchyma cells of *Gleditschia triacanthos* showing penetration by hyphae of *Thyronectria denigrata* which interlace in spaces between cells. Scale 10 μ.

FIG. 6. Cross-section of stromatic hyphae of *Thyronectria denigrata* showing unusual method of formation of conidia within the stroma without conidiophores. Scale 10 μ.

FIG. 7. Conidiophores of *Thyronectria denigrata* arising from stromatic cells, show typical attenuations, branching, and nuclear distribution. Detached conidia are sketched between the two groups of conidiophores. Scale 10 μ.

FIG. 8. Conidia of *Thyronectria denigrata* showing typical central nucleus and variations in size. Scale 10 μ.

FIG. 9. Conidia under conditions of high moisture showing swelling as a preliminary to germination. Typically the protoplasmic contents are forced to the center. Scale 10 μ.

FIG. 10. Cross-section of young stroma with five well developed locules lined with conidiophores of varying length, which produce conidia. Three of the locules are excentrically cut. The section shows the tough outer crust and the somewhat loosely arranged pseudoparenchyma just beneath. The constrictions at the sides mark the upper limits of the periderm tissue bordering the lenticel through which the stroma emerged. Scale 10 μ.

FIG. 11. Early conidial germination. Scale 10 μ.

FIG. 12. Conidial germination showing formation of cross walls and secondary conidia. Scale 10 μ.

FIG. 13. Cross-section of a stroma somewhat more advanced than that of fig. 10, showing at the extreme left an excentric cut through a young perithecium and at its right eight distinct areas of perithecial initials. Periderm tissue may be distinctly seen at the lower left (× 92).

FIG. 14. A portion of a cross section of a stroma showing a strongly stained Woronin hypha at *a* and an excentric view of a conidial chamber filled with conidia at *b* with a dark boundary of densely staining short conidiophores. At the periphery may be seen a number of other incipient initials whose increase in size over those in fig. 13 is notable. The surface also shows the crust typical of older stromata (× 78).

FIG. 15. Compact young stromatic growth of *Thyronectria denigrata* on agar showing two small conidial chambers, *b* and *c*, and a columnar structure, *a*, which was erroneously construed as a possible receptive hyphal structure (× 95).

FIG. 16. Cross-section through a perithecial aggregate on wood showing a variety of stages of perithecial development from initials, *b*, maturing perithecia at *a* and mature perithecia at the periphery. The altered character of the woody substratum may be seen (× 28).

FIG. 17. Hyphae which result from three ascospores growing on agar film for five days, show typical septations, branching, and conidial formation. The hyaline hyphae have been stained with methyl blue in lactophenol for photographic purposes (× 70).

FIG. 18. Cross-section of *Thyronectria denigrata* hyphae in and on Difco cornmeal agar with three dense tufts of palisade-like conidiophores at the surface and five isolated branched conidiophores, the tallest of which shows the limits attained by this fungus in petri dish cultures (× 163).

FIG. 19. Cross-section of a developing perithecium showing periphyses at *a*, paraphyses at *b*, and asci, perithecial wall, and surrounding stromatic material (× 70).

FIG. 20. Cross-section of a "pycnidium" grown on cornmeal agar, showing a basal cushion of conidiophores at *a*, a central locule with a few suspended tufts of conidiophores arising from hyphae which penetrate the agar (× 95).

FIG. 21. A portion of a cross-section of a perithecium showing the delicate inner perithecial wall at *a*, separated from the enclosing material. The perithecium also shows developing asci and ascospores and remnants of the paraphyses and periphyses (× 185).

FIG. 22. A portion of a cross-section of a perithecial wall. The inner wall of the perithecium may be seen at *a;* the outer wall at *b;* the stromatic cells at *c* (× 185).

FIG. 23. A portion of a cross-section of a perithecium showing paraphyses at *a;* asci with young ascospores at *b* (× 235).

FIG. 24. Cross section through a perithecial initial showing one turn of the coil with its denser cytoplasm and numerous darkly stained nuclei, surrounded by cells somewhat smaller and more compactly arranged than the stromatic cells. Scale 10 μ.

FIG. 25. Typical branched paraphyses squeezed out of a young perithecium. Scale 10 μ.

FIG. 26. A cross-section of a young perithecium showing periphyses in ostiolar region and paraphyses in the central cavity. A few ascogenous hyphae may be seen arising from the tile like perithecial wall cells. The irregular line at the periphery marks the limits of the loose stromatic material enclosing the perithecium. Scale 10 μ.

FIG. 27. Paraphyses with typical branching and anastomoses and asci in various stages of maturity arise from wall cells of a maturing perithecium. Camera lucida sketch by Miss L. B. Walker. Scale 10 μ.

FIG. 28. Cross-section of a perithecium more mature than that illustrated in fig. 26, showing developing asci and ascospores gelatinizing paraphyses, and periphyses. Scale 10 μ.

FIG. 28–33. Ascogenous hyphae. Scale 10 μ.

FIG. 34–39. Stages in development of ascus and delimitation of ascospores. Scale 10 μ.

FIG. 40–41. Stages in development of ascospores. Scale 10 μ.

FIG. 42–43. Aberrant ascospore development. Scale 10 μ.

FIG. 44–45. Old ascospores in perithecia breaking up into conidia, which may occasionally proceed to germinate in situ as in fig. 45. Scale 10 μ.

FIG. 46. *Thyronectria denigrata* asci held under high moisture conditions show complete breakdown of ascus wall and germination of ascospores. Scale 10 μ.

FIG. 47. *Thyronectria sphaerospora* spores as seen in nature at left; an ascospore germinating and showing typical conidia seen at right.

HARPOSPORIUM ANGUILLULAE

J. S. KARLING

(WITH 18 FIGURES)

In 1874 Lohde (**5**) described an unusual fungus parasite of *Anguillula* with cresentric or sickle-shaped conidia borne on basidia-like conidiophores to which he gave the name *Harposporium Anguillulae* and placed near the genus *Fusisporium* in the Hyphomycetes. Two years later Sorokin (**10**) figured and described a very similar parasite of the same host which he believed to be identical with Lohde's species, but he none the less renamed it *Polyrhina multiformis* and included it in the Chytridiales. He described the globular cells that bear the conidia as sporangia and claimed that they form small, .5 μ in diameter, zoöspores which escape through a neck and become motile. According to his account the sterigmata described by Lohde are thus nothing more than the curved necks of sporangia. Sorokin (**11, 12**) reported this fungus again in 1883 and 1889, but did not find motile zoospores. In 1888 Zopf (**14**) gave an excellent description of *H. Anguillulae* and reported for the first time the presence of intramatrical, thick-walled resting cells. He refuted Sorokin's claim as to sporangia and zoöspores and maintained that *H. Anguillulae* and *P. multiformis* are identical. In 1890 Dangeard (**2**) described and figured it from France, and he is in full agreement with Zopf that *P. multiformis* is the same as Lohde's fungus and not a new chytrid. *Harposporium Anguillulae* has subsequently been reported from North America by Bisby, Buller, and Dearness (**1**) and Sparrow (**13**), who also confirm Zopf's conclusions.

Inasmuch as I have been studying the chytrids for a number of years, Sorokin's claim as to the presence of zoösporangia and chytridiaceous zoöspores has often excited my interest in the possibility that he may have had a different fungus at hand. Recently in the course of a study of species of *Rhizophidium* which occur on dead infusoria, rotifers, etc., numerous nematodes in-

fected with *H. Anguillulae* were found. I have accordingly had the opportunity of making an intensive study of the development of the conidiophores and conidia and of checking Sorokin's contention. Since the general structure and development of this fungus has been so well described and figured by Zopf, I shall confine my account largely to the progressive developmental stages of the conidiophores and conidia.

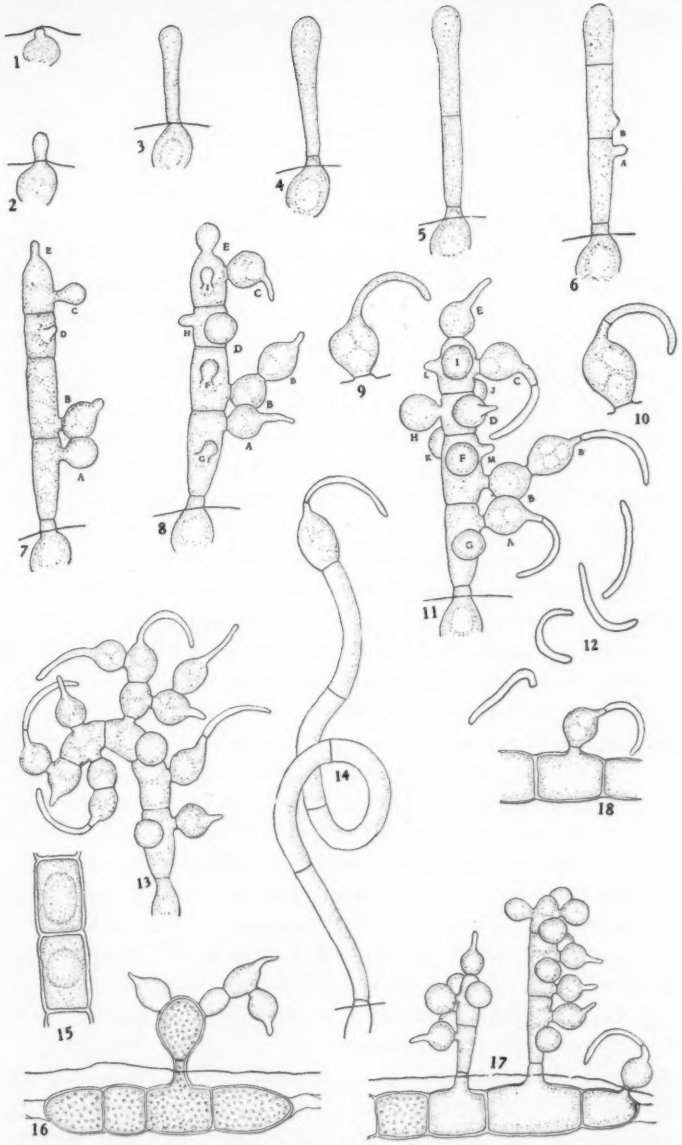
DEVELOPMENT OF THE CONIDIOPHORES AND CONIDIA

The successive developmental stages of a conidiophore at different time intervals are shown in figures 1 to 11. The branch of the internal mycelium which is to form the conidiophore may often become enlarged and globular like an appressorium as it pushes against the wall of the host (FIG. 1), but this is not the general rule, as Zopf has already shown in his drawings. I have, none the less, chosen to illustrate the formation of a conidiophore with a bulbous internal base of this type. Figure 1 shows an early stage drawn at 1 P.M. From the apex of the bulbous structure, which I shall for the sake of convenience call an appressorium, a papillate bud grows out which eventually pierces the wall, and in so doing it may frequently cause the latter to bulge in that region. The appressorium, when present, may measure 5–7 μ in diameter, and its protoplasm is usually dense and nonvacuolate at this stage. Figure 2 shows the same organ at 2 P.M., an hour later. The papillate bud has pierced the host wall and now extends 3 μ beyond, but no other marked changes are visible. Its appearance by 4 P.M. is shown in figure 3. The incipient conidiophore is now 15 μ long and somewhat swollen at the apex, while the appressorium has become vacuolate. In figure 4, drawn at 6 P.M., the conidiophore has become delimited from the bulbous internal base by a cross wall, and increased considerably in diameter and length. The cross septum is usually formed a short distance outside of the host wall and may sometimes appear earlier than is shown in figure 4. In a few instances observed it was formed when the incipient conidiophore was only 5–7 μ long.

The same conidiophore at 8 P.M. is shown in figure 5. It is now 26 μ long, and a second septum has been formed dividing it

into two fairly equal cells. As in the case of the first septum, the second may also be formed earlier, depending to a large degree on the ultimate size and length of the conidiophore. In figure 6, drawn at 10 P.M., a third septum is shown, and on the first and second cells of the conidiophore two lateral buds have appeared. These are the primordia of the globular cells which are to bear the conidia. Zopf calls these globular cells basidia, which is not particularly descriptive, since they are nothing more than short oval and spherical branches of the conidiophores. In small and short conidiophores they may appear soon after the first septum is formed. With the view of presenting the sequence of their development, I have labeled these primordia in alphabetical order. Very frequently at this stage and even earlier the cells of the conidiophore may become slightly inflated, so that the whole structure is somewhat constricted in the region of the cross walls. By 12 P.M. development had proceeded considerably farther, as is shown in figure 7. The conidiophore now consists of four linear segments, and the primordia of three additional globular cells have appeared on the third and fourth segments. At this stage the conidiophore begins to look very much like the basidium of certain Basidiomycetes. The first two primordia, *a* and *b*, have now become globular and are subtended by a very short stalk or pedicle. Cell *b* in particular has been delimited from the linear segment by a cross wall and now rests on a barely perceptible pedicle. The cytoplasm of the linear segments has by this time become less dense and more vacuolate, but still retains its optical homogeneity. Figure 8 shows the conidiophore at 3 A.M. the following morning. Four new primordia have appeared in the meantime, cell *b* has formed a secondary globular one *b1*, while *a* and *c* have been delimited by cross walls and formed elongated beaks at their apices. These latter may now be recognized as the rudiments of the sterigmata and conidia.

Mindful of Sorokin's claims, I have given special attention to the succeeding stages of conidial development. Cell *a* is shown in greater magnification in figure 9, which was drawn at 6 A.M. The beak has elongated into a curved, cylindrical structure which is about to be abstricted as a conidium. It is filled with hyaline, optically homogeneous protoplasm which shows no marked struc-



FIGS. 1–11, successive developmental stages of a conidiophore and conidia drawn at different time intervals; 12, a group of conidia; 13–14, larger, more complex and elongated conidiophores; 15–16, chlamydospores; 17–18, germination of chlamydospores.

tural differentiation. The protoplasm in the globular cell, on the other hand, is vacuolate, and at this stage it is not uncommon to find the greater part of the cell occupied by a large central vacuole. By 7:30 A.M. a cross wall had been formed (FIG. 10), thus finally delimiting the spore. This wall is usually formed a short distance beyond the apex of the globular cell, and after the conidium has dropped off, the sterigma persists as a short pointed peg. In the development of the globular cell and the maturation of the conidium, no cleavage of the protoplasm into segments nor their transformation into zoöspores were observed. I have followed these developmental stages a number of times without finding any evidence to confirm Sorokin. In old cultures small oval and short rod-shaped bacteria have occasionally been found in the vicinity of the conidiophore and its globular cells, and it is not altogether improbable that Sorokin may have mistaken these for chytridiaceous zoöspores.

The mature conidiophore as it appeared at 11 A.M. is shown in figure 11. Three mature conidia have been formed, and four additional globular cells have arisen in the meantime. This conidiophore was studied for 10 more hours, but nothing of further significance occurred except the formation of four additional conidia. It is thus obvious from the above description that the development of a conidiophore and its conidia is a relatively slow process and may occupy a large number of hours. This may vary from 16 to 38 hours for the large conidiophores, according to my observations, but in the case of very small ones it may be much shorter. After the formation of conidia has been completed, the globular cells and linear segments of the conidiophore become very vacuolate, and the cytoplasm is usually reduced to a thin primordial utricle surrounding a large central vacuole. So far I have never seen a globular cell form more than one conidium. Figure 12 shows a group of conidia. They are hyaline, continuous, and scolecosporus, and measure 1.5–2.5 $\mu \times$ 5–14 μ. The globular cells on which they are formed vary from 2.5–5 μ in diameter. The size, shape, and length of the conidiophore may also vary considerably, as Lohde, Sorokin, and Zopf have already shown. They may range from 6–60 μ in length and 2.5–4 μ in breadth. The number of linear segments may be reduced to 2

or 1, and in rare cases, they may be lacking entirely so that only a globular cell with a single conidium is present. Figure 13 shows a complex curved conidiophore bearing secondary, tertiary, and quaternary globular cells, while in figure 14 is shown an unusually elongate and coiled one which measured 60 μ in length. It consists of five linear segments and is terminated by an oval cell which bears the conidium. It is accordingly obvious that *H. Anguillulae* may develop a very simple or highly complex structure to bear its conidia.

CHLAMYDOSPORES

Thick-walled, intramatrical hyaline resting cells of the type described by Zopf have frequently appeared in my material. They may occur singly or in chain-like groups, and are usually rectangular, slightly swollen, somewhat oval and barrel-shaped. They vary from 4–6.6 μ in diameter and 3.5–7 μ in length and are sometimes almost isodiametric. When young their content is usually greyish and coarsely granular (FIG. 16), but after they become older a large refractive globule may appear in the center, as Zopf and I have illustrated in our figures 8 and 15, respectively. In view of their intercalary occurrence and the fact that their development does not appear to involve sexuality, they are to be regarded, it seems to me, as chlaymdospores. Figure 16 shows a rare and unusual case in which the basal segment of conidiophore has become swollen and encysted, forming thus an extramatrical chlamydospore.

So far, only a few developmental stages of these spores have been observed, and I am unable to give a detailed account of their formation. In the initial stages, the protoplasm in the mycelium begins to contract and becomes denser, and as this continues, the mycelial cells in those regions increase in diameter. Eventually such cells apparently encyst and become enveloped by thick walls. The length of the individual chlamydospores is usually much less than that of the mycelial cells, which suggests that secondary cross walls are formed before or during contraction and encystment. I have not, however, observed such stages.

Numerous germinating chlamydospores have been found in my material. In this process the refractive material becomes highly

dispersed, so that the cytoplasm eventually has a finely granular appearance. The wall of the spore then becomes thinner in a localized region, and at that point a small papilla pushes out. With further growth this develops into a conidiophore of the type described above and as is shown in figures 17 and 18. These conidiophores also may vary considerably in size, length, and shape, and in the number of conidia borne. Small chlamydospores may often bear a single globular cell and one conidium (FIG. 17, 18).

SUMMARY

No evidence of sporangia or zoöspores has been found in my material, and I am accordingly of the opinion of Lohde, Zopf, and Dangeard that *Harposporium Anguillulae* and *P. multiformis* are identical and that the latter binomial should be stricken from the chytrid group, as Zopf, Fischer (**3**), Minden (**7**), and others have done. Schroeter (**9**), Saccardo (**8**), and Migula (**6**), however, recognize it as valid. Schroeter and Migula in particular include it in the family Hypochytriaceae of the chytrids, while Fitzpatrick (**4**) regards it as a doubtful genus.

In our present state of knowledge, *H. Anguillulae* is a hyphomycetous species, and because of its hyaline mycelium, conidia, and chlamydospores belongs in the family Mucidinaceae. Although the conidia are not particularly long, they are nevertheless scolecosporus and should, in my opinion, be included in that spore division.

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NEW BOLETES

WILLIAM A. MURRILL

Specimens cited in this article have been deposited in the herbarium of the Florida Agricultural Experiment Station. Mr. Erdman West, Mycologist of this Station, has kindly made microscopic studies of the spores. Dr. F. J. Seaver and Dr. J. H. Barnhart, of the New York Botanical Garden, have arranged for comparisons with certain southern types and for the checking of names.

Florida is very rich in boletes during the period of summer rains, when the native species appear at their best. The tourist collector may see a few species like *Boletus luteus* and *Rostkovites granulatus,* that love cool weather even in their northern habitat, but he has no idea of the vast quantity of delicious food going to waste in the summer months. A practical rule for amateur mycologists in central Florida is to avoid all boletes with red tube-mouths and to taste the others, rejecting those that are bitter.

Gyroporus roseialbus sp. nov.

Pileus convex to expanded, solitary or gregarious, reaching 5–7 cm. broad; surface smooth, glabrous, milk-white, becoming ochraceous in part or white with a rosy tint; context firm, white, unchanging, sweet; tubes small, pallid to dirty-yellowish; spores oblong-ellipsoid, smooth, hyaline, 11–13 × 4–5 μ; stipe bulbous, smooth, glabrous, white or rosy-isabelline, paler above, solid, white and unchanging within, 4–6 × 1–2 cm.

Pileo 5–7 cm. lato, glabro, roseo-albo vel albo dein ochraceo; carne alba, sapore grato; tubulis albidis dein isabellinis; sporis hyalinis, 11–13 × 4.5 μ; stipite glabro, albo vel roseo-isabellino, 4–6 × 1–2 cm.

Type collected by W. A. Murrill under an oak in Gainesville, Fla., August 6, 1937 (No. *15864*). Also collected by the author at Gainesville under oaks or pines (Nos. *F 9287, F 9288, F 9292*). This species may be confused by the amateur with *Tylopilus feralbidus,* but may readily be distinguished by its taste or a

spore-print. From *G. subalbellus* it differs in its rosy tints, glabrous surface, and solid stipe.

Tylopilus peralbidus (Snell & Beard.) comb. nov.

Pileus convex, gregarious to closely cespitose, reaching 10 cm. broad; surface dry, smooth, glabrous, white or yellowish to partly or wholly isabelline, at times subfulvous; context firm, bitter, pallid, becoming slightly dirty or purplish when cut; tubes small, white with a faint pinkish tint, becoming isabelline when bruised or with age; spores very slender, smooth, hyaline under the microscope but rose-colored in mass, 9.5–10.5 × 2.5 μ; stipe subequal, rather short and thick, 4–6 × 1–2 cm., concolorous, isabelline when bruised, not reticulate, pallid within, sometimes as many as five united into a common enlarged base.

The above description was prepared for publication before I saw Mr. Snell's article. The plant is not pure white; the flesh is decidedly bitter and inedible; and the spores form a beautiful rosy print. It is one of our most abundant summer species and I have been collecting it here under oaks and pines for over ten years (Nos. *F 9283–5, F 9289, F 9290, F 9291, 15870–75*).

Tylopilus subflavidus sp. nov.

Pileus at length slightly depressed, rather thin, solitary, 10 cm. broad; surface dry, floccose-squamulose, uniformly yellow; margin entire, fertile, concolorous; context white, unchanging, distinctly bitter but less so than in *T. felleus;* tubes violet-pink, suggesting *Stropharia,* small, rather short, adnate; spores subfusiform, smooth, dark rose-colored, 15.5–18 × 6–7 μ; stipe subequal, curved, concolorous, hollow, strongly and coarsely reticulate throughout to the bulbous base, 10 × 3–5 cm.

Pileo dein subdepresso, 10 cm. lato, floccoso-squamuloso, flavido; carne alba, immutabili, sapore amaro; tubulis violaceo-roseis; sporis roseis, subfusiformis, 15.5–18 × 6.7 μ; stipite concolore, reticulato, bulboso, 10 × 3–5 cm.

Type collected by W. A. Murrill in rich garden soil under pines in Gainesville, Fla., August 14, 1937 (No. *15862*). Known only from the type collection. A remarkable and beautiful species with yellow cap and coarsely reticulate stem. The spores are dark-roseous under the microscope, which explains the violet-pink tubes.

Ceriomyces alachuanus sp. nov.

Pileus solitary, convex, 3 cm. broad; surface smooth, glabrous, slightly viscid when moist, uniformly bay-fulvous; context firm, sweet, white, becoming very slightly pinkish when cut; tubes small, not stuffed when young, pale-yellowish, unchanged when cut; spores oblong-ellipsoid, smooth, yellowish-brown, 10–12 × 3.5–5 μ; stipe tapering downward, not reticulate, smooth, dry, glabrous, subconcolorous but streaked, solid and white within, 4 × 1 cm.

Pileo 3 cm. lato, glabro, badio-fulvo; carne alba, sapore grato; tubulis cremeis, immutabilis; sporis flavo-brunneis, 10–12 × 3.5–5 μ; stipite glabro, subcremeo, 4 × 1 cm.

Type collected by W. A. Murrill on the ground in a hammock south of Newnan's Lake, Alachua County, Florida, Jan. 9, 1938 (No. *15860*). Known only from this one collection.

Ceriomyces aureissimus sp. nov.

Pileus convex, gregarious, reaching 12 cm. broad; surface smooth, glabrous, flavous; context paler yellow, unchanging, firm, sweet, edible; tubes small, flavous, unchanging when cut, darker when the spores mature; spores slender, smooth, yellowish-brown, 11–13 × 3.5 μ; stipe of average length and thickness, smooth or finely reticulate, rarely coarsely so, concolorous without, paler yellow within, unchanging.

Pileo 12 cm. lato, glabro, flavo; carne flava, immutabili, sapore grato; sporis flavo-brunneis, 11–13 × 3.5 μ; stipite glabro vel reticulato, flavo. Var. castaneus differt in pileo purpureo-brunneo, subtomentoso.

Type collected by W. A. Murrill under a laurel oak in Gainesville, Fla., August 3, 1937 (No. *15857*). Often collected here for food, sometimes by the peck, and much esteemed by the few who know it. It seems to grow best under young laurel oaks. A coarsely reticulate specimen is No. *15867*. A rare and beautiful variety, **C. aureissimus castaneus** var. nov., found under laurel oaks has a purplish-brown surface appearing like rich velvet because of a fine tomentum. It is No. *15876* and also No. *F 9278*.

Ceriomyces flavissimus sp. nov.

Pileus solitary to subcespitose, convex, thick, reaching 15 cm. broad; surface smooth, glabrous, bright-yellow, unchanged on drying, margin concolorous; context firm, sweet, yellow, becoming

slightly bluish when bruised; tubes adnate, small, short, yellow to discolored, becoming bluish-green when wounded; spores oblong-ellipsoid, smooth, yellowish-brown, 9.5–10.5 × 3–3.5 μ; stipe usually tapering downward, not reticulate, reddish-yellow, bright-yellow within, becoming very slightly bluish when cut, solid, 5 × 2–3 cm.

Pileo 15 cm. lato, glabro, laete flavo; carne flava, sapore grato; tubulis flavis, vulneratis cyaneo-viridibus; sporis flavo-brunneis, 9.5–10 × 3–3.5 μ; stipite glabro, rubro-flavo, 5 × 2–3 cm.

Type collected by W. A. Murrill under a water oak on a lawn in Gainesville, Fla., August 6, 1937 (No. *15858*). Also collected by W. A. Murrill under an oak in Gainesville, Fla., August 21, 1937 (No. *15856*).

Ceriomyces inedulis sp. nov.

Pileus convex to expanded, gregarious, 7–12 cm. broad; surface firm, dry, smooth, minutely tomentose to glabrous, uniformly avellaneous-isabelline or dark-isabelline, margin sterile; context pale-yellow, bright-blue at once when bruised, decidedly bitter, about 1 cm. thick; tubes 5 mm. long, small, pale-yellow, changing to bluish-green when wounded; spores oblong-ellipsoid, smooth, yellowish-brown, 9.5–10.5 × 3.5–4 μ; stipe yellow, flecked or streaked with red, smooth or reticulate at the apex, equal, solid, pale-yellow within, dark-red at the base, 5–6 × 1 cm.

Pileo 7–12 cm. lato, tomentuloso dein glabro, avellaneo-isabellino vel atro-isabellino; carne cremea, cyanescente, amara; tubulis cremeis, cyaneo-viridescentibus; sporis flavo-brunneis, 9.5–10.5 × 3.5–4 μ; stipite flavo, rubro-punctato, glabro vel apice reticulato, 5–6 × 1 cm.

Type collected by W. A. Murrill under an evergreen oak on a lawn in Gainesville, Fla., July 31, 1937 (No. *15865*). Also collected by the author under evergreen oaks at Gainesville (Nos. *F 9295, 15859, 15861, 15866*). This species might be confused with *C. pallidus*, but the surface is not soft and flexible, the margin is widely sterile, and the flesh decidedly bitter. I cooked and ate three sporophores without really harmful effects, but the mess was highly distasteful, hence the name chosen.

Ceriomyces luridellus sp. nov.

Pileus convex, gregarious to subcespitose, about 6 cm. broad; surface dry, smooth, minutely tomentose, yellowish-brown, some-

what streaked, margin irregular, splitting at times; context firm, sweet, yellow, changing to blue when cut; tubes small, yellow, becoming blue where cut, mouths not at all red, becoming slightly reddish-brown when bruised; spores slender, smooth, yellowish-brown, 12–13 × 3.5–4.5 μ; stipe equal, yellow above, brownish-red and punctate below, reticulate throughout or only at the apex, about 5 × 2 cm.

Pileo 6 cm. lato, tomentuloso, flavo-brunneo; carne flava, cyanescente, sapore grato; tubulis flavis, cyanescentibus; sporis flavo-brunneis, 12–13 × 3.5–4.5 μ; stipite reticulato, brunneo-rubro et punctato, apice flavo, 5 × 2 cm.

Type collected by W. A. Murrill under an evergreen oak at Gainesville, Fla., August 18, 1937 (No. *15863*). This species has the general form and appearance of *Suillellus luridus* but the tube-mouths are not at all red and the plant is otherwise entirely distinct. Only one collection was made.

Ceriomyces projectellus sp. nov.

Pileus convex, not fully expanding, gregarious, about 3–4 cm. broad; surface dry, smooth, minutely tomentose, reddish-brown, margin broadly sterile and overhanging like the edge of a roof; context pale rose-colored, unchanging when cut; tubes small, greenish-yellow, depressed about the stipe; spores remarkable both for size and shape, decidedly fusiform, yellowish-brown, 23–27.5 × 7–9.5 μ; stipe dry, slender, tapering upward, concolorous or paler, ornamented with long raised lines and beautifully reticulated at the apex, 7–10 × 0.5–1 cm.

Pileo 3–4 cm. lato, tomentuloso, rubro-brunneo, margine projecto, carne subrosea, immutabili; tubulis depressis, viridi-flavis; sporis permagnis, fusiformis, flavo-brunneis, 23–27.5 × 7–9.5 μ; stipite subconcolore, apice reticulato, 7–10 × 0.5–1 cm.

Type collected by W. A. Murrill among leaf-mold in pine woods at Lynchburg, Va., August 17, 1928 (No. *F 9296*). As shown by the author's photograph herewith reproduced, this species may at once be distinguished by its widely projecting sterile margin. Only this one group of several plants was found.

Suillellus subluridus sp. nov.

Pileus convex, gregarious, 7–15 cm. broad; surface glabrous, smooth or cracked, flavous or orange with purple stains, or entirely purplish-red; context not very firm, sweet, flavous, un-

changing when cut; hymenium yellowish or reddish or deep purple-red to dark-red; tubes constricted when young but not stuffed, pallid within, becoming bluish-green when wounded; spores slender-smooth, yellowish-brown, 11–14 × 3–3.5 μ; stipe concolorous, not reticulate, flavous and unchanging within, becoming bluish-green without when bruised, about 5–7 × 2 cm.

Pileo 7–15 cm. lato, glabro, flavo vel aurantio vel purpureo-rubro; carne flava, immutabili, sapore grato; hymenio flavo-rubro vel atro-rubro; tubulis cyanescentibus; sporis flavo-brunneis, 11–14 × 3–3.5 μ stipite concolore, glabro, cyanescente, 5–7 × 2 cm.

Type collected by W. A. Murrill under evergreen oaks at Gainesville, Fla., August 21, 1937 (No. *15869*). Also No. *15868*. This species is readily distinguished from *S. luridus* by its unchanging flesh. The tube-mouths, also, are thick-walled and yellow with tracings of dark-red color speckled over the high points. I ate five of the caps without the slightest ill effects. Insects often attack the tubes but apparently avoid the flesh, which is noticeably light in weight when dried. In *Boletus rubritubifer* Kaufm. the flesh is yellowish-white, unchanging, but the entire tubes are deep-red and the spores are 9–12 × 4 μ.

NEW COMBINATIONS

For those using the older nomenclature the species described above are here transferred to *Boletus:*

Gyroporus roseialbus	= **Boletus roseialbus**
Tylopilus subflavidus	= **Boletus subflavidus**
Ceriomyces alachuanus	= **Boletus alachuanus**
Ceriomyces aureissimus	= **Boletus aureissimus**
Ceriomyces flavissimus	= **Boletus flavissimus**
Ceriomyces inedulis	= **Boletus inedulis**
Ceriomyces luridellus	= **Boletus luridellus**
Ceriomyces projectellus	= **Boletus projectellus**
Suillellus subluridus	= **Boletus subluridus**

GAINESVILLE, FLORIDA.

THE DISCHARGE OF CONIDIA IN SPECIES OF ENTYLOMA[1]

W. F. HANNA[2]

(WITH 1 FIGURE)

Marshall Ward (**13**), in describing his experiments with *Entyloma Ranunculi,* the fungus causing the so-called "white smut" of *Ranunculus Ficaria,* directed attention to two types of conidia that he found in the white spots on infected leaves. Of these conidia he wrote: "In some cases, apparently in drier warm weather, the protruding hyphae are relatively short, and the conidia ovoid or slightly reniform; in other cases, apparently in wet weather, and certainly in water, the hyphae may protrude twice as far before the conidia are abstricted, and the latter are then longer, more curved, and relatively thinner."

The ovoid, slightly reniform conidia to which Ward referred at the beginning of the above passage were regarded by him as "normal" conidia, and were described further as being "club-shaped or long ovoid bodies, slightly curved, and more pointed at the attached end." The "longer, more curved, and relatively thinner conidia," he apparently considered to be the product of somewhat abnormal environmental conditions.

Previous to Ward's experiments other investigators had found that conidia were frequently associated with infections caused by species of *Entyloma.* Sometimes these conidia were described as the spores of other fungi and, according to Ward (**13**), their connection with *Entyloma* was first suggested by Winter.

De Bary (**7**), in his discussion of *E. Ficariae,* drew attention to the "gonidia" or "secondary conidia" formed on the mycelium before the resting spores. He stated that these conidia "ap-

[1] Contribution No. 550, Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Canada (Continuing the Series of the former Division of Botany).

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pear to the naked eye as a slight sprinkling of flour or mould on the spot which is attacked in the leaf." In all probability the spores to which de Bary referred were none other than the structures described by Ward as "normal conidia." No mention, however, is made by de Bary of the "longer . . . and relatively thinner conidia" described and figured by Ward.

Judging from taxonomic descriptions of species of *Entyloma,* the long, narrow type of conidium is the one most commonly met with on the host plant. Structures of this kind are stated to be present in some species and absent in others, and on the basis of this difference certain taxonomists (**4**, **10**) have divided the species of *Entyloma* into two groups. According to Clinton (**4**) the function of these conidia is to "spread the smut over the host or to new hosts." Only in one of the taxonomic works consulted by the writer is particular reference made to a second type of conidium. This occurs in a description of *E. Ranunculi* (**5**) where the following statement, apparently based upon Ward's observations, is made: "Conidia apparently of two types, either long fusiform, . . . or short fusiform." The omission of any further reference to the shorter conidia suggests that they are either absent from most species or, if present, are so similar in appearance as to be of little value in taxonomy.

THE CONIDIA FOUND IN INFECTIONS CAUSED BY SPECIES OF ENTYLOMA

The species of *Entyloma* most commonly met with about Winnipeg is *E. Menispermi.* This fungus is found on *Menispermum canadense,* and it was in 1928, while examining infected leaves of this plant that the writer first became interested in the conidia of *Entyloma.* In the whitish pustules occurring on the leaves there were found two distinct types of conidia: the long filiform conidia frequently associated with species of *Entyloma,* and also an abundance of sickle-shaped conidia resembling the secondary conidia of *Tilletia.* Subsequently, a microscopic examination was made of other species of *Entyloma* with the result that in the infections caused by a number of them the same two types of conidia were found. A summary of these observations, together

with comments on the conidia as given in "North American Flora," will be found in table 1.

TABLE I

OCCURRENCE OF CONIDIA IN SPECIES OF ENTYLOMA

Species	Remarks on conidia in "North American Flora"	Examination of infected leaves		
		Host	Filiform conidia	Sickle-shaped conidia
E. Menispermi....	Subclavate or fusoid	*Menispermum canadense*	Present	Present
E. australe.....	Linear, somewhat curved	*Physalis pruniosa*	"	"
E. Linariae.....	Apparently lacking	*Linaria vulgaris*	"	"
E. Meliloti.....	——	*Melilotus indica*	"	"
E. Ranunculi.....	Apparently of two types, either long-fusiform, often curved, or short-fusiform, often curved near tip	*Ranunculus Macounii*	"	"
E. Nymphaeae....	Not observed	*Nymphaea advena*	Absent	"
E. Lobeliae.....	Narrowly fusiform	*Lobelia inflata*	"	"
E. Compositarum..	Fusoid or slightly clavate, often curved	*Ambrosia trifida*	"	Absent
E. polysporum....	Evidence of conidia usually lacking	*Gaillardia* sp.	"	"

In the infections produced by five of the nine species listed in the above table both types of conidia were found. In those produced by two others, only the sickle-shaped conidia were present, and in the two remaining species conidia were apparently lacking. These findings are not in complete agreement with the statements given in "North American Flora," where, for example, conidia are reported as being "apparently lacking" in *E. Linariae* and present in *E. Compositarum,* whereas in the specimens under examination both types of conidia were present in the first of these species and absent in the second. Conidia of the two types were also found in infections produced by *E. Meliloti.* This species is not listed in "North American Flora," but in McAlpine's (**9**) description of it no mention is made of conidia.

In considering the results of the examinations just referred to, a question naturally arises as to the value of the conidia of *Enty-*

loma as specific diagnostic characters. It has already been pointed out that in the descriptions of most species no clear distinction is made between the two types of conidia. Furthermore, it is now apparent that the presence of either type of conidia may depend upon the age and condition of the host-plant at the time the specimens are collected. Such a supposition would account for the statement that conidia are "apparently lacking" in *E. Linariae,* and a re-examination of other species in which conidia are considered not to occur might reveal their presence. The omission of any reference to conidia in descriptions of species such as *E. Meliloti* may be due to the fact that these structures were overlooked, although actually present in the material on which the species were based.

THE DISCHARGE OF SICKLE-SHAPED CONIDIA IN CULTURES OF ENTYLOMA

While examining the pustules produced by *E. Menispermi* on *Menispermum canadense,* a striking resemblance was noted between the sickle-shaped conidia of this species and the secondary conidia of *Tilletia.* Buller and Vanderpool (**2**) had already shown that these secondary conidia, in common with the basidiospores of the Hymenomycetes and the Uredineae, and the spores of *Sporobolomyces,* were violently discharged from their sterigmata with the accompaniment of the excretion of a drop of liquid at the spore-hilum. It was this discovery, together with the asymetrical manner of spore-attachment, which led Buller and Vanderpool to conclude that the secondary conidia of *Tilletia* are true basidiospores.

In view of the similarity in appearance between the secondary conidia of *Tilletia* and the sickle-shaped conidia of *Entyloma Menispermi,* it was thought possible that the latter might also exhibit the phenomenon of violent spore-discharge. To test this possibility small pieces of tissue cut from the pustules on infected leaves were plated out in a Petri dish on the surface of plain agar. This dish was then inverted over a second Petri dish also containing agar. The following day the agar surfaces in the lower dish situated immediately below the pieces of tissue were examined under the microscope. Scattered over these areas there were

found numerous sickle-shaped conidia, many of which had already germinated and produced hyphae.

It is a matter of common observation that ordinary spores produced in a moist atmosphere do not readily become detached from the hyphae on which they are borne. In view of this fact it seemed highly probable that the sickle-shaped conidia on the surface of the lower plate had been discharged from the pieces of tissue immediately above. Closer microscopic examination of the colonies in the lower plate revealed that on the hyphae arising from the germinated conidia further sickle-shaped conidia were developing and that at maturity they were being discharged from their sterigmata with the accompaniment of drop-excretion. Subsequently violent discharge of sickle-shaped conidia was observed in cultures of *E. Lobeliae* (FIG. 1, *H*) and *E. Linariae* made respectively from infected tissue of *Lobelia inflata* and *Linaria vulgaris*. A brief reference to these observations has already been made by Buller (**3**).

Further investigations will probably show that the process of production and discharge of sickle-shaped conidia is common to cultures of all species of the genera *Entyloma* and *Tilletia*. Since the above observations were made, cultures of *Entyloma polysporum* (from *Gaillardia* sp.) and *E. Nymphaeae* (from *Nymphaea advena*) have been secured by plating out pieces of infected leaf tissue on plain agar and suspending them above a Petri dish containing potato-dextrose agar. These cultures produced an abundance of sickle-shaped conidia which were discharged from their sterigmata with the accompaniment of drop-excretion. The same phenomenon was also reported recently by Stempell (**12**) in cultures of *E. Calendulae* and *E. Ranunculi*.

No difficulty has been experienced in growing species of *Entyloma* in pure culture. The five referred to grow well on both malt and potato-dextrose agar, and after more than six years on artificial media cultures of *E. Menispermi*, *E. Lobeliae* and *E. Linariae* still continue to produce and discharge sickle-shaped conidia. If a freshly-made Petri-dish culture is inverted above a second dish containing nutrient agar a heavy deposit of conidia may be gathered in the lower dish. This provides a convenient method of transferring cultures, and at the same time gives a

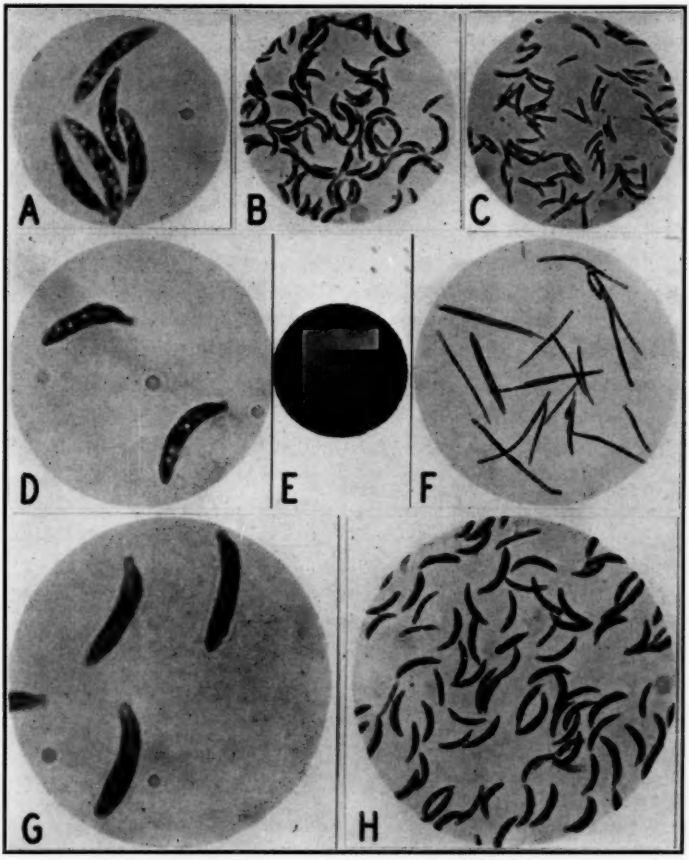

FIG. 1. *A* and *H*, sickle-shaped conidia from cultures of *Entyloma Lobeliae*; *B–C*, sickle-shaped conidia from two different cultures of *E. Nymphaeae*; *D*, sickle-shaped conidia from a culture of *E. Linariae*; *E*, letter formed on a plate of nutrient agar by inverting above it a culture of *E. polysporum* from which sickle-shaped conidia were being discharged; *F*, filiform conidia from a culture of *E. polysporum* stained with lacto-phenol light-green, × 340; *G*, sickle-shaped conidia from a culture of *E. Menispermi*. Conidia shown in figures *A*, *D*, and *G* stained with safranin and gentian violet, × 1400; those in figures *B*, *C*, and *H* stained with lacto-phenol cotton blue, × 510.

striking demonstration of spore discharge (FIG. 1, *E*). Certain differences have been observed in the growth characteristics of the species under consideration but these are not sufficiently pronounced to be used as specific diagnostic characters. Moreover, a study of cultures made from individual sickle-shaped conidia of *E. Menispermi, E. Lobeliae,* and *E. Linariae* has shown that some variation exists between cultures of a single species. This intraspecific variation was most noticeable in cultures of *E. Menispermi.*

From leaves of *Nymphaea advena* infected with *Entyloma Nymphaeae* there were obtained cultures of two distinct types, differing from one another in the shape and size of their conidia (FIG. 1, *B–C*). The cultures producing the smaller conidia, when grown on potato-dextrose agar, caused the medium to turn dark-brown in colour. This reaction was never given by the cultures producing the larger conidia. Cultures of *E. Menispermi, E. Lobeliae, E. Linariae,* and *E. Nymphaeae* can all bring about liquefaction of gelatin. This change is effected most rapidly by cultures of *E. Nymphaeae,* which are able to reduce dextrose-gelatin or malt-extract-gelatin slants in 24 hours. *E. Nymphaeae* is also able to soften potato-dextrose agar, and slants on which cultures of this species have been growing for four days collapse and run to the bottom of the tube. The power of softening agar has never been noticed in the other species of *Entyloma.*

Brief references have been made elsewhere (**3**, **8**) to the nuclear condition of the sickle-shaped conidia of species of *Entyloma.* The three species investigated were *E. Menispermi, E. Lobeliae,* and *E. Linariae.* Conidia from Petri-dish cultures of these species were collected on glass slides to which a thin film of egg-albumen fixitive had previously been applied. The slides were then fixed in Flemming's weaker solution and stained with safranin and gentian-violet. Microscopic examination of these preparations showed that the sickle-shaped conidia of all three species were for the most part uninucleate (FIG. 1, *A, D, G*). In another species, *E. Ranunculi,* recently investigated by Stempell (**12**), the sickle-shaped conidia were also found to be uninucleate. It is apparent, therefore, that the sickle-shaped conidia produced in culture by species of *Entyloma* correspond in nuclear condition as

well as in shape and method of discharge with the conidia of haploid cultures of *Tilletia laevis* and *T. Tritici.* In the latter species it was shown by Rawitscher (**11**) that the binucleate phase is initiated by the union of two uninucleate sporidia. These fused sporidia, in turn, give rise to sickle-shaped primary conidia which are also binucleate (**1**, **6**). In pure culture, however, the binucleate phase is of short duration, for on germination the primary conidia yield secondary sickle-shaped conidia which are uninucleate (**1**, **6**, **8**). These uninucleate conidia are indistinguishable both morphologically and cytologically from the sickle-shaped conidia of cultures originating from single sporidia. Furthermore, it has been shown (**8**) that when wheat plants are inoculated with either a single monosporidial culture or a culture derived from a single secondary conidium they fail to produce bunted heads, and this has been regarded as proof that the sporidia and secondary conidia of *T. Tritici* are haploid. In view of the close relationship that exists between *Tilletia* and *Entyloma,* together with the similarity in the appearance of their conidia, and the highly specialized manner in which they are discharged, it will probably be found that the sickle-shaped conidia of *Entyloma* are also haploid and of two sexually different kinds. If this were so, it might then be expected that plants would become infected if inoculated with sickle-shaped conidia of opposite sex. In nature these conidia are produced on the host-plant in great abundance and, like the sporidia of the rust fungi, are admirably adapted by their method of discharge for dispersal by air from plant to plant.

In all of the species of *Entyloma* that have been discussed the conidial phase of the life cycle is passed in the uninucleate condition. An exception to this apparent rule was encountered by Stempell (**12**) in *E. Calendulae.* He found that certain cultures of this species had uninucleate hyphae on which were borne uninucleate sickle-shaped conidia. Other cultures possessed a more rapidly growing mycelium, consisting of thick binucleate hyphae, on which were borne "halbmondkonidien." This mycelium in pure culture maintained its original binucleate character and never produced uninucleate hyphae or sickle-shaped conidia. Of particular interest also is the fact that the binucleate mycelium was

provided with numerous clamp connections similar in all respects to those occurring in the Hymenomycetes. Both the sickle-shaped conidia and the "halbmondkonidien" were asymetrical in shape and were discharged from their sterigmata with the accompaniment of drop-excretion. The "halbmondkonidien," however, were relatively thick, resembling in appearance the sporidia of the rust fungi. When germinated on artificial media they give rise to a binucleate mycelium bearing clamp connections which, in from two to three weeks, produced binucleate chlamydospores corresponding in appearance and size with those produced on the host plant. Nuclear fusion was never observed in the chlamydospores produced in culture, and on germinating they failed to develop typical promycelia. Bodies having the appearance of chlamydospores were formed also in cultures of the uninucleate mycelium, but in each of them there was but a single nucleus.

In many species of the Hymenomycetes the presence of clamp connections is a distinguishing feature of the diploid mycelium. These structures occur at frequent intervals on the hyphae, are formed in a definite manner, and are remarkably uniform in appearance. At various times structures resembling clamp connections have been observed on the mycelium of the smut fungi but, because of their appearance and the irregularity of their occurrence, doubt as to their true nature has been expressed. One of the greatest difficulties in detecting clamp connections in the smut fungi arose from the fact that the diploid phase occurred only on the host plant and had never been maintained in pure culture. This difficulty has at last been overcome by Stempell, and his drawings and photomicrographs show conclusively that the clamp connections occurring in diploid cultures of *E. Calendulae* are indistinguishable from those of the Hymenomycetes. In conclusion, however, it should be pointed out that although Stempell obtained both the uninucleate and binucleate cultures from leaves infected with *E. Calendulae,* he did not reinfect plants with these cultures and thereby establish the connection between them and *E. Calendulae.* Confirmation of this relationship would remove any remaining doubt as to the presence of clamp connections in the smut fungi.

THE OCCURRENCE OF FILIFORM CONIDIA IN CULTURES OF ENTYLOMA

All of the species of *Entyloma* that were grown in pure culture produced sickle-shaped conidia. Filiform conidia as well developed in abundance in cultures of *E. Linariae*, *E. Nymphaeae*, and *E. polysporum* (FIG. 1, *F*), but they were absent in cultures of *E. Menispermi* and *E. Lobeliae*. The average size of these conidia in cultures of *E. Linariae* and *E. polysporum* was $35 \times 2\,\mu$, and in cultures of *E. Nymphaeae* $20 \times 2\,\mu$. In appearance they resembled the filiform conidia found on plants infected with certain species of *Entyloma* (Table 1). A light touch with an inoculating loop is sufficient to detach them from the mycelium on which they are borne but, unlike the sickle-shaped conidia, they are not violently discharged. In nature they are probably set free by drops of rain and serve to spread the fungus from plant to plant.

SUMMARY

1. The infections produced by nine species of *Entyloma* were examined for the presence of conidia.

2. Some species (*E. Menispermi*, *E. australe*, *E. Linariae*, *E. Meliloti*, and *E. Ranunculi*) produced two distinct types of conidia, the one sickle-shaped and the other filiform; other species (*E. Nymphaeae*, and *E. Lobeliae*) produced conidia of the one type only. In two species (*E. Compositarum*, and *E. polysporum*) conidia were apparently absent.

3. Pure cultures of *E. Menispermi*, *E. Linariae*, *E. Lobeliae*, *E. polysporum*, and *E. Nymphaeae* were made by suspending pieces of infected tissue above Petri dishes containing nutrient agar. All of these cultures produced sickle-shaped conidia which were violently discharged from their sterigmata with the accompaniment of drop-excretion. The cultures of *E. Linariae*, *E. polysporum*, and *E. Nymphaeae* produced also filiform conidia. These conidia were easily detached from the hyphae on which they were borne but were not discharged.

4. The sickle-shaped conidia of *E. Menispermi*, *E. Lobeliae*, and *E. Linariae* are for the most part uninucleate.

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ADDITIONS TO THE UREDINALES OF VENEZUELA *

FRANK D. KERN

In 1927 H. Sydow collected fungi in Venezuela and in 1930 in his published list, Fungi Venezuelani (Ann. Myc. **28**: 37–52), he reported 65 species of rusts. Further collecting was done subsequently by Messrs. Chardon, Toro, Gonzalez, Soltero, and Röhl. In 1934 Kern, Thurston, and Whetzel published an account of the Uredinales of Venezuela (Monographs of the University of Puerto Rico, Series B. No. 2: 262–303) which was said to include an additional 115 species, bringing the total up to 184. We have discovered an error (see under *Puccinia puta* in this paper) which means that the total should have been 183.

Studies of the rust flora of Venezuela have been proceeding since the publication of the Kern, Thurston, and Whetzel list. Several specimens which were then at hand have been determined so that they can now be reported. Some additional references in the literature have been discovered. By far the largest recent contribution to our knowledge has come through a collecting trip by R. A. Toro and the author in 1934. There are approximately one hundred collections of rusts from this expedition upon which a report can now be made.

The exploration of Professor Toro and the author was the fifth expedition in a series sponsored jointly by the University of Puerto Rico and the Venezuelan government. The earlier expeditions are described in detail in the Mycological Explorations of Venezuela by Chardon and Toro (Monographs of the University of Puerto Rico, Series B. No. 2: 19–58, 1934). This fifth expedition covered in part the same territory as the first three expeditions. There was one important difference in the conditions. The other expeditions were all made during the rainy season—ours was made not only during the dry season but well

* Contribution from the Department of Botany, The Pennsylvania State College, no. 108.

toward the end of the dry season. It was so dry in places that practically all foliage had dropped from the shrubs and trees. Grasses were frequently so dried up that no parasites could flourish. In one locality we were told that there had not been a drop of rain for five months. Mycologists will appreciate the fact that such conditions are not conducive to a luxuriant development of rusts.

For the success of our expedition thanks are due to numerous friends and officials and are hereby accorded. In the determination of hosts we were aided by Dr. Henri Pittier personally and by his book " Manual de las Plantas de Venezuela (1926)." We appreciated the opportunities extended to us for the use of the Herbarium in the Commercial Museum in Caracas. We are also indebted to several phanerogamic botanists in the United States for responding to our appeals for help. In Venezuela we were indebted to various officials for material aid. We were fortunate indeed to come in contact with a considerable number of people who encouraged us and gave us assistance of one sort or another. Without such splendid coöperation it would have been impossible for two collectors to make much headway. We are very appreciative of the many courtesies extended to us during our stay in the country.

From these various sources there are added here 22 species to the previous lists, bringing the total up to 205. This compares favorably with the 215 species reported from Colombia. In addition it is possible to include notes for 14 other species. These notes deal with changes in names, additional hosts, extension of distribution, and other items of interest.

There are described in this paper four new species. At least three of the others, *Puccinia rubigo-vera, Puccinia polysora,* and *Uromyces striatus,* are of economic interest since they attack wheat, Guatemala grass, and alfalfa respectively. In addition to the new species three others, *Puccinia polysora, Puccinia Heliotropii,* and *Puccinia Kuhniae,* are new to South America. Some of the species such as *Aecidium goyazense* and *Chrysocyclus Cestri* are of more than usual biologic interest. Notes accompanying the species indicate the chief points of interest.

AECIDIUM ADENARIAE Mayor, Mem. Soc. Neuch. Nat. Sci. **5**: 556. 1913.

On *Pehria compacta* (Rusby) Sprague (*Grislea compacta* Rusby), hills Petare-Sta. Lucia road, alt. 1200–1250 m., Est. Miranda, July 8, 1932, *Chardon & Toro 433*.

This is the first report of this interesting species outside of Colombia. It is here reported on a different genus but one very closely related to *Adenaria*. There is another specimen no. *434* which seems to us to agree very well with no. *433* at least as to the fungus, but we cannot be sure about the identity of the host.

AECIDIUM CORDIAE P. Henn.; Bres. Henn. & Magn. Bot. Jahrb. **17**: 491. 1893.

On *Cordia curassavica* (Jacq.) R. & S., Monai, alt. 298 m., Est. Trujillo, May 15, 1934, *Kern & Toro 1836*.

This interesting *Aecidium*, with spores having the wall thicker above, was reported previously from Burro Island, Valencia Lake on *Varronia globosa* (*Cordia globosa*).

The specimens here reported were in fine condition. A thorough search was made for a possible connection. A few uredosori were found on a grass which turned out to be *Sporobolus indicus* (L.) R. Br. (our no. *1837*). We cannot match this *Uredo* to any known *Sporobolus* rust. The spores are 23–26 × 29–34 μ, with 3–6 equatorial pores. The fact that they have walls slightly thicker above seems significant. Paraphyses are present. No teliospores were found. We hesitate to describe a new species, but we feel that we have here a very probable heteroecious combination.

AECIDIUM GOYAZENSE P. Henn. Hedwigia **34**: 101. 1895.

On *Struthanthus dichotrianthus* Eichl., road from Barquisemeto to Carora, alt. 600 m., Est. Lara, May 6, 1934, *Kern & Toro 1778*.

Several species have been described on genera belonging to the Loranthaceae. A careful study should be made of all the forms

on this family. In the habit of bearing the aecia on small galls on the stems as well as on both sides of the leaves our specimen seems to agree best with the description of *A. goyazense* on *Phthirusa ovata* from Brazil. *Aecidium bulbifaciens* Neg. on *Loranthus heterophyllus* from Chile is very similar. There are two species, *Aecidium Struthanthi* Jackson & Holw. and *Uromyces socius* Arth. & Holw., on the genus *Struthanthus* but our specimen does not agree in peridial cell or spore characters with either of these. While in Venezuela we germinated the spores of our collection and found them to be a true *Aecidium* germinating with long germ tubes.

AECIDIUM SERJANIAE P. Henn. Hedwigia **35**: 258. 1896.

On *Serjania mexicana* Willd., road Los Rastrojos to Sarare alt. 450 m., Est. Lara, May 5, 1934, *Kern & Toro 1751;* road Trentino to Pampan, alt. 520 m., Est. Trujillo, May 6, 1934, *Kern & Toro 1764.*

According to Sydow (Monog. Ured. **4**: 334) there is some doubt about the standing of this name. Sydow has examined the original material upon which Henning founded the name and says that there is not a trace of an *Aecidium* to be found. Later, however, Sydow distributed a typical *Aecidium* in his exsiccati (Sydow Ured. *2197*) which he called *Aecidium Serjaniae.* After finding the difficulty with the Henning material he was in some doubt about the determination of the host plant.

The material here cited has an abundance of aecia. They are on colored spots, mostly in circular groups and the spores are small, 13–16 × 16–19 μ. In these characters they agree perfectly with the description given by Henning. Henning's specimens were from Argentina. I see no other alternative than to use the Henning name.

This *Aecidium* is without much doubt a stage of the heteroecious species which is correlated with *Puccinia Arechavelatae* Speg., a microcyclic species which is common in the American tropics on *Serjania* and other hosts belonging to the Sapindaceae.

It would seem that an *Aecidium* on the Sapindaceae is rare as none has been reported previously from Venezuela or Colombia or by Jackson in his account of the Holway collections.

AECIDIUM TOURNEFORTIAE P. Henn. Hedwigia **34**: 338. 1895.

On *Tournefortia cuspidata* HBK., Hcda. Santa Barbara, El Palmar, Est. Bolivar, Nov. 8, 1932, *H. Soltero 1547, 1549.* *Tournefortia peruviana* Poir., Cordero, alt. 1600 m., Est. Tachira, May 9, 1934, *Kern & Toro 1804.*

The collection, no. *1804,* is abundant and well developed. No possible connection could be found. In South America it has been reported previously only from Brazil. It is known also in Puerto Rico, Santo Domingo, Cuba, and Panama.

CHRYSOCYCLUS CESTRI (Diet. & P. Henn.) Sydow, Ann. Myc. **23**: 322. 1925.

Chrysopsora Cestri Arth. Bull. Torrey Club **51**: 53. 1924.

On *Cestrum* sp., between Rastrojos and Sarare, alt. 450 m., Est. Lara, May 5, 1934, *Kern & Toro 1747.*

This was a very conspicuous specimen when in the fresh condition. The sori form perfect concentric rings in groups 7–15 mm. in diameter. The outermost rings were young and bright orange-red in color. It has a gross appearance of a rust but the spores, especially the immature ones from the outer rings do not present what are ordinarily considered typical rust-like characters. Not having flowers or fruit of the host, we were puzzled at first as to the identity of the host. I am indebted to my colleague, Professor Toro, for the studies which finally led to the identification of both host and rust. This is the first report of this interesting species from Venezuela. It is known from Brazil, Central America and Cuba.

MARAVALIA INGAE Sydow, Mycologia **17**: 257. 1925.

Ravenelia Ingae Arth. N. Am. Flora **7**: 132. 1907.

Specimens from Venezuela on *Inga* have been reported as *Ravenelia Ingae* Arth.

All these Venezuelan specimens have the primary uredo, or aecia, with striate markings on the spores. Dr. G. B. Cummins points out that such spores were assumed by Arthur to have a *Ravenelia* telial stage but no such spores have been found on any

specimens. On the contrary similar specimens from Puerto Rico and elsewhere have associated with the striate spores teliospores of a whitish nature which are like the genus *Maravalia*. In some cases the association between the striate spores and the *Maravalia*-like teliospores is surely rather strong.

Originally the genus *Maravalia* was described as having a microcyclic life-cycle. Here the new concept of the genus includes uredinoid aecia and true uredinia. It may not be beside the point to call attention to the fact that the revised *Maravalia* has many characters in common with the genus *Mainsia* (*Spirechina*).

PHAKOPSORA JATROPHICOLA (Arth.) Cummins, Bull. Torrey Club **64**: 43. 1937.

Uredo jatrophicola Arth. Mycologia **7**: 331. 1915.

Cummins, working with a specimen from Lower California, Mexico, has found teliospores surrounding the uredinia so that the reference of the species to the genus *Phakopsora* is possible. The rust is common in tropical America. Our report was on *Jatropha Curcas* L.

PROSPODIUM CONCINNUM Sydow, Ann. Myc. **28**: 45. 1930.

In the previous list we included the species *Prospodium concinnum* Sydow on the basis of a specimen collected by Sydow on *Tecoma chrysantha* in La Victoria, Venezuela, which is the type. We do not have additional specimens from Venezuela but we do have one from Brazil which undoubtedly is the same thing. In continuing our studies we have had some correspondence with Dr. G. B. Cummins in which he has expressed the opinion that this species is the same as *Prospodium tecomicola* (Speg.) Jackson & Holw. If that is correct the latter name takes precedence.

Prospodium venezuelanum sp. nov.

Uredosoris hypophyllis, sparsis vel saepe in maculis decoloratis dense aggregatis, rotundatis, minutis, 0.1 mm. minusve diam., pulverulentis, pallide cinnamomeo-brunneis, superficialibus; paraphysibus copiosis, incurvis, basi coniunctis, circa sporas sportulam efformantibus, fusiformibus, 5–7 × 19–35 μ, tunica levi, tenui; uredosporis globosis, 19–21 × 20–23 μ; tunica cinnamomeo-

brunnea, 1.5–2 μ cr., prominenter spinis hyalinis conicis 2–2.5 μ longis echinulata; poris 2, aequatorialibus.

Teleutosoris uredosoris conformibus; teleutosporis late ellipsoideis, 21–23 × 26–29 μ, supra et infra rotundatis, ad septum leniter constrictis; tunica flavida vel pallide cinnamomeo-brunnea, tenui, ca. 1 μ, apparenter levi, ad apicem papilla hyalina 2–3 μ longis praedita; pedicello hyalino, brevi, fragili, deciduo.

On *Tecoma pentaphylla* Juss., road Los Rastrojos to Sarare, alt. 450 m., Est. Lara, May 5, 1934, *Kern & Toro 1748*.

This species differs from any of the numerous species on *Tecoma* in the spore characters. The spores here do not have noticeably laminate walls. Also these teliospores are nearly or quite smooth which is apparently a rare condition in the genus *Prospodium*. The pedicels are short and no appendages were seen. The superficial nature of the sori was particularly noticeable in the first studies made. No marks are evident on the cuticle or epidermis when sori are removed for mounting. I am indebted to Dr. G. B. Cummins of Purdue University, for pointing out the true structure of the sori. He writes that they are extrastomatal. A small stalk of more than one hypha grows out through a stoma and produces a sorus not otherwise attached to the leaf. Dr. Cummins, who is making a study of this genus, has found that several of the species have this interesting extrastomatal development in the uredinia and telia while others have ordinary subepidermal sori. (See Ann. Myc. **35**: 15–21. 1937.)

PUCCINIA ACANTHOSPERMI P. Henn. Hedwigia **41**: 296. 1902.

On *Acanthospermum xanthioides* DC., Caracas, *Moritz*.

We have not seen this specimen. The reference is taken from Sydow's Monographia Uredinearum **1**: 849. 1904.

PUCCINIA ARACHIDIS Speg. Anal. Soc. Ci. Argent. **17**: 90. 1884.

On *Arachis hypogaea* L., San Cristobal, Est. Tachira, Oct. 24, 1933, *J. I. Otero 1625*.

First report for Venezuela, although previously known in South America; also in West Indies and southern United States.

Puccinia araguata nom. nov.

Puccinia paspalicola Kern, Thurston, Whetzel, Monog. Univ. P. Rico B. **2**: 284. 1934 (Oct.). Not *P. paspalicola* Arth. 1934 (June).

As indicated here the name *Puccinia paspalicola,* proposed in the previous report, is invalidated by an earlier use and *Puccinia araguata* is proposed for the Venezuelan specimen, no. *600,* collected in the state of Aragua on *Paspalum microstachyum.*

PUCCINIA ATRA Diet. & Holw.; Holway, Bot. Gaz. **24**: 29. 1897.

On *Tricachne insularis* (L.) Nees (*Valota insularis* Chase), Los Caobos, alt. 920 m., Dist. Federal, April 28, 1934, *Kern & Toro 1717.*

Pennisetum peruvianum Trin., Cobre-Cordero road, alt. 1600 m., Est. Tachira, May 9, 1934, *Kern & Toro 1802.*

This rust, first known in Mexico and Central America, was reported from Bolivia and Brazil by Arthur from the Holway collections. This is the first report of it from Venezuela. The urediniospores with walls 2.5–3.5 μ thick, and 4–6 equatorial pores are characteristic. No telia are present.

PUCCINIA CANNAE (Wint.) P. Henn. Hedwigia **41**: 105. 1902.

On *Calathea* sp., Ocumare de la Costa, Est. Aragua, Dec. 25, 1930, *R. A. Toro 108.*

A new host for Venezuela. Previously reported from Panama and Puerto Rico on this host.

PUCCINIA CONOCLINII Seym. Bot. Gaz. **9**: 191. 1884.

On *Ageratum conyzoides* L. var. *mexicanum* (Sims) DC., Mérida, alt. 1626 m., Est. Mérida, May 7, 1934, *Kern & Toro 1784B.*

Only uredinia are present on this collection but there can be no doubt that this is the *Ageratum* rust which Mayor described as *Uredo Agerati* from Colombia and which was referred to *Puccinia Conoclinii* by Arthur. There may be some question whether the variety of the host is correctly given here.

PUCCINIA DICHROMENAE (Arth.) Jackson, Trans. Brit. Myc. Soc. **13**: 16. 1928.

On *Dichromena ciliata* Vahl, El Cedral, road to Los Teques, alt. 1200–1300 m., Est. Miranda, June 26, 1932, *Chardon, Toro & Alamo 322.*

The first report from Venezuela but a common rust wherever the host occurs.

PUCCINIA DISTINGUENDA.

See *Puccinia puta.*

PUCCINIA GRAMINIS Pers. Neues Mag. Bot. **1**: 119. 1794.

Puccinia poculiformis (Jacq.) Wettst. Verh. Zool.-Bot. Ges. Wien. **35**: 544. 1886.

On *Polypogon elongatus* HBK., German truck farm, Timotes, alt. 2030 m., Aug. 31, 1932, *C. E. Chardon 1033.*

This specimen was not in the earlier list because the host was not determined at that time. This species was in the list on other hosts under the name *Puccinia poculiformis.* This rust has been reported previously from Ecuador on *Polypogon elongatus.*

PUCCINIA HELIOTROPII Kern & Kellerm. Jour. Myc. **13**: 23. 1907.

On *Heliotropium indicum* L., Tariba, near San Cristóbal, Est. Tachira, Jan. 13, 1933, *P. Gonzalez 1611.*

The first report of this species outside of Guatemala, where three collections are known, the type, another specimen collected by Kellerman in 1905, and a specimen collected by Holway in 1916.

PUCCINIA HYPTIDIS-MUTABILIS Mayor, Mem. Soc. Neuch. Sci. Nat. **5**: 496. 1913.

On *Hyptis mutabilis* (Rich.) Briq., road to Carabobo Monument, alt. 400–420 m., Est. Cojedes, May 4, 1934, *Kern & Toro 1742.*

Hyptis sp. Mérida, alt. 1626 m., Est. Mérida, May 7, 1934, *Kern & Toro 1785.*

This collection has uredospores only. They agree so well with those of *Puccinia Hyptidis-mutabilis* that we make this determina-

tion with confidence. This is the first report from Venezuela. Jackson has reported it from Brazil and Ecuador. It is known also from Costa Rica and Trinidad.

PUCCINIA KUHNIAE Schw. Trans. Am. Phil. Soc. II. **4**: 296. 1832.

On *Brickellia diffusa* (Vahl.) Gray, Cotiza, alt. 900 m., Dist. Federal, April 23, 1934, *Kern & Toro 1700.*

We have found no rusts reported from South America on *Brickellia* (*Coleosanthus*). In North America there are three species *Puccinia Kuhniae* Schw., *P. decora* Diet. & Holw., and *P. subdecora* Sydow & Holw. The last named species has teliospores with rough walls and is different from the others which have smooth walls. Both *P. Kuhniae* and *P. subdecora* are known in Mexico. These two species are much alike. The Venezuelan collection agrees so well with *P. Kuhniae* that it is placed here with much confidence.

Puccinia Lasiacidis sp. nov.

Uredosoris hypophyllis, intercostalibus vel sparsis, rotundatis vel ellipsoideis, minutis, 0.1–0.5 mm. longis, mox nudis, pulverulentis, pallide cinnamomeo-brunneis, epidermide rupta conspicua; paraphysibus paucis, capitatis, levibus, tunica tenui praeditis; uredosporis plerumque obovoideis, 18–21 × 23–27 μ; tunica flavida vel pallide cinnamomeo-brunnea, tenui, ca. 1 μ, moderate echinulata; poris 3–4, aequatorialibus.

Teleutosoris uredosoris conformibus, obscure cinnamomeo-brunneis; teleutosporis late ellipsoideis, 18–21 × 23–30 μ, supra et infra rotundatis, non vel leniter septo constrictis; tunica pallide cinnamomeo-brunnea, 1–2 μ cr., apice incrassata, 2–3 μ, levi; pedicello tenui, sporam aequante vel duplo-longiore, saepe oblique inserto.

On *Lasiacis divaricata* (L.) Hitch., reservoir on Dominguez farm, Chacao, alt. 960 m., Dist. Federal, April 28, 1934, *Kern & Toro 1718.*

The genus *Lasiacis,* or the *Lasiacis* section of the genus *Panicum,* is composed of woody and elongated vine-like grasses. There are reported on these grasses two species, *Uromyces costaricensis* Sydow and *Angiospora lenticularis* Mains. The species here described is the first *Puccinia* and appears to be distinctive as might be expected on such a well defined host.

PUCCINIA LEVIS (Sacc. & Bizz.) Magnus, Ber. Deuts. Bot. Ges. **9**: 190. 1891.

On *Paspalum pilosum* Lam., collected at Caracas by *Stevens*.

We have not seen this specimen which is reported by Arthur (The grass rusts of South America, based on the Holway collections. Proc. Am. Phil. Soc. **64**: 177. 1925). It adds a host.

PUCCINIA MEDELLINENSIS Mayor, Mem. Soc. Neuch. Sci. Nat. **5**: 497. 1913.

On *Hyptis canescens* HBK., Mérida, alt. 1626 m., Est. Mérida, May 7, 1934, *Kern & Toro 1784A;* Ocumare, Est. Aragua, Dec. 25, 1930, *R. A. Toro 113.*

The previous collection on which this species was reported from Venezuela was from the vicinity of Mérida but bore aecia only. The Kern and Toro specimen has both uredinia and telia. The teliospores are slightly longer than the measurements ordinarily given for this species but otherwise the characters agree well.

Puccinia meridensis sp. nov.

Uredosoris plerumque hypophyllis, sparsis, elongato-oblongis, 0.4–0.8 mm. longis, mox nudis, rufo-brunneis, plus minusve pulverulentis, epidermide rupta visible; uredosporis globosis vel late ellipsoideis, 21–24 × 23–29 μ; tunica pallide cinnamomeo-brunnea, 2–3 μ cr., minute verrucosa; poris 4–6, sparsis vel subinde apparenter aequatorialibus.

Teleutosporis in uredosoris permixtis, late ellipsoideis, 16–21 × 29–35 μ; tunica pallide cinnamomeo-brunnea vel flavida, 1.5–2 μ cr., levi, apice 4–7 μ incrassata; mesosporis numerosis, 16–19 × 26–29 μ.

On *Andropogon altus* Hitch., Bailadores, alt. 1745 m., Est. Mérida, May 8, 1934, *Kern & Toro 1798* (type).

Andropogon saccharoides Sw., gardens below town of Timotes, alt. 2000 m., Est. Mérida, Aug. 29, 1932, *C. E. Chardon 1010.*

This species is characterized by urediniospores with verrucose walls and light-colored teliospores most of which are mesospores. There is no previously known species in North or South America on *Andropogon* with such characters.

There is a species in Europe on *Andropogon* which is similar and which may be said to be a parallel species. The European species has, in general, larger spores with thicker and darker walls. The description of the European species sounds like this species but a comparison of the specimens reveals that they are really quite distinct.

PUCCINIA PASPALICOLA.

See *Puccinia araguata,* also *Puccinia tubulosa.*

PUCCINIA POCULIFORMIS.

See *Puccinia graminis.*

PUCCINIA POLYSORA Underw. Bull. Torrey Club **24**: 86. 1897.

On *Tripsacum laxum* Nash, Dominguez farm, Chacao, alt. 960 m., Dist. Federal, April 28, *Kern & Toro 1725.*

This rust was collected from a planting where the host, Guatemala grass, was being cultivated. Only the uredo stage was found, but it was well developed and doing more or less damage. The fact is recalled that shortly after Guatemala grass was established as a crop in Puerto Rico the rust appeared there. It is likely that the rust will follow the cultivation of this grass. This appears to be the first report from South America.

PUCCINIA PUTA Jackson & Holw. in Kern, Thurston & Whetzel, Mycologia **25**: 477. 1933.

In the previous list we included this species and also *Puccinia distinguenda* (Sydow) Jackson & Holway as if both were valid species whereas there is only one species. The valid name is *Puccinia puta* which was proposed because there was already a name *Puccinia distinguenda* Sydow of an earlier date, belonging to entirely different species, thus invalidating the combination *Puccinia distinguenda* Jackson & Holw.

Kern and Toro collected the aecial stage on *Ipomoea carnea* Jacq. (no. *1777*) in a dry ravine between Barquisimeto and Ca-

rora, May 6, 1934, apparently the same place where Chardon collected his no. *918*.

PUCCINIA RUBIGO-VERA (DC.) Wint. in Rab. Krypt.-Fl. **1**: 217. 1881.

Puccinia Clematidis Lagerh. Tromsö Mus. Aarsh. **17**: 54. 1895.

On *Triticum aestivum* L. Bailadores, alt. 1745 m., Est. Mérida, May 8, 1934, *Kern & Toro 1796b*.

Without doubt this leaf rust occurs everywhere that wheat is grown. However, it has not been reported previously from Venezuela. Arthur (The grass rusts of South America based on the Holway collections. Proc. Am. Phil. Soc. **64**: 160–163. 1925) lists 22 grass hosts from several countries, but reports it on wheat from Chile only. It has been reported from Colombia.

PUCCINIA SUBSTRIATA Ellis & Barth. Erythea **5**: 47. 1897.

On *Eriochloa polystachya* HBK., between Los Rastrojos and Sarare, alt. 450 m., Est. Lara, May 5, 1934, *Kern & Toro 1752*.

Paspalum humboldtianum Flugge, Galipan, Dist. Federal, April 23, 1934, *Kern & Toro 1698b*.

These are new hosts for this species so far as the previous lists of Colombia or Venezuela, or Arthur's South American grass rusts, are concerned. We are indebted to Dr. A. S. Hitchcock for these determinations. Field evidence indicated a possible connection between the rust on *Eriochloa polystachya* and the *Aecidium Serjaniae* (*Kern & Toro 1751*).

PUCCINIA TUBULOSA (Pat. & Gaill.) Arth. Am. Jour. Bot. **5**: 464. 1918.

On *Paspalum decumbens* Sw., Ocumare, alt. 1350 m., Est. Aragua, April 26, 1934, *Kern & Toro 1710*.

The species listed under this name in the previous report is now called *Puccinia paspalicola* (P. Henn.) Arth. by Arthur in Man.

Rusts U. S. and Canada, p. 127 (1934). The reason for the change is the adoption of the principle of rejecting names founded on aecial stages. It is to be noted, however, that Arthur accepts names founded on uredinial stages of which this is an example.

RAVENELIA INGAE.

See *Maravalia Ingae*.

UREDO JATROPHICOLA.

See *Phakopsora jatrophicola*.

Uredo Melinidis sp. nov.

Uredosoris amphigenis, ellipsoideis vel oblongis, 0.3–1 mm. longis, cinnamomeo-brunneis, mox nudis, epidermide rupta conspicua; uredosporis plerumque late ellipsoideis vel obovoideis, 21–27 × 27–35 μ; tunica ca. 1.5 μ, pallide cinnamomeo-brunnea, minute denseque echinulata; poris 3, plus minusve aequatorialibus.

On *Melinis minutiflora* Beauv., road to Galipan, alt. 900–1500 m., Dist. Federal, April 23, 1934, *Kern & Toro 1690;* Dominguez farm, Chacao, alt. 960 m., April 28, 1934, *Kern & Toro 1722* (type); San Carlos, alt. 420 m., Est. Cojedes, May 4, 1934, *Kern & Toro 1738*.

This uredo-form has no particular outstanding characters, but its host relationship is the basis for considering it a new species. No rust has been reported on this grass so far as we can determine. Nothing has been found which seems even closely related. There is in our herbarium a specimen from Brazil.

UROMYCES BONARIENSIS Speg. Anal. Soc. Ci. Argent. **10**: 133. 1880.

On *Gomphrena iresinoides* Moq. (*Pfaffia iresinoides* Spreng.), El Pinar, Caracas, April 22, 1934, *Kern & Toro 1674*.

In our first Venezuelan report we were uncertain about the standing of this species. We have since had opportunity to study further these forms and some closely related ones. We have had for comparison a specimen of *Uredo argentina* Speg. which

Spegazzini says is the same as *Uromyces bonariensis* Speg. Our specimens agree well. Jackson has reported *U. bonariensis* from Ecuador and also accepts *U. argentina* as a synonym. He says the urediniospores of *P. Mogiphanis* are different and our studies support his conclusion.

In the course of our investigations we have run across a specimen collected by Baker in Nicaraugua on *Gomphrena* (no. *2361*) which we believe to be *U. bonariensis* and extends its range into North America. Two specimens on *Gomphrena* from Mexico mentioned by Sydow (Monog. Ured. **2**: *227*) as probably belonging to *U. bonariensis* have been examined and do not belong here.

There is listed here one specimen in addition to the six in the previous report. It does not extend the range.

UROMYCES FABAE (Pers.) DeBary, Ann. Sci. Nat. IV. **20**: 80. 1863.

On *Vicia Faba* L., Hcda. Bramón, near Rubio, alt. 1100 m., Est. Tachira, July 3–7, 1933, *P. Gonzalez 1596.*

A cosmopolitan species now reported for the first time from Venezuela.

UROMYCES HEDYSARI-PANICULATI (Schw.) Farl.; Ellis, N. Am. Fungi *246.* 1879.

On *Meibomia frutescens* Jacq., road from La Mulera to San Cristóbal, alt. 1050 m., Est. Tachira, Sept. 17, 1932, *C. E. Chardon 1252.*

This specimen extends both the geographical and host range over the previous report.

UROMYCES POIRETIAE Sydow, Ann. Myc. **32**: 287. 1934.

On *Poiretia scandens* Vent., Caracas, November, 1854, a phanerogamic specimen in the Dahlem Botanical Museum, collected by *Gollmer.*

A new rust discovered by Herr Sydow on an old phanerogamic collection. The host belongs to the Leguminosae.

UROMYCES STRIATUS Schroet. Abh. Schles. Ges. **48**: 11. 1870.

Uromyces Medicaginis Pass. Thüm. Herb. Myc. Oecon. *156*. 1874.

On *Medicago sativa* L. Hcda. Bramón, alt. 1100 m., Est. Tachira, May 10, 1934, *Kern & Toro 1815*.

Although this rust seems to be more or less common wherever alfalfa is grown, this seems to be the first report from northern South America. It has been reported previously from Argentina and southern Brazil. Our collection bears only uredospores.

THE PENNSYLVANIA STATE COLLEGE,
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A PORIA AS THE FRUITING STAGE OF THE FUNGUS CAUSING THE STERILE CONKS ON BIRCH

W. A. Campbell and Ross W. Davidson

(with 3 figures)

Introduction

The identity of the sterile fungus, so common on living birches in certain localities, and its relation to other fungi have long been disputed. It has usually been considered a sterile form of some *Fomes* species. Lindroth (**5**) and Neger (**6**) described sterile conks on living birches in Europe and called them abortive sporophores of *Polyporus nigricans* Fries. Weir (**9**) mentioned the occurrence of the sterile fungus and normal sporophores of *Fomes igniarius* (L.) Gill. on the same tree and considered the two to be the same. He found the sterile form associated with dead, sunken, canker-like areas on the trunks of living birches and suggested that moisture and freezing and thawing coupled with certain chemical substances within the wound, maintained the mycelium in a vegetative condition, thus preventing the formation of normal sporophores. Katayevskaya (**4**) studied *F. igniarius* and the sterile fungus in culture and, although she demonstrated marked differences in the appearance and in microscopic structures of the isolates from the two sources, tentatively identified the latter as a sterile form of *F. igniarius*. Verrall (**8**) in an extensive study of variation in *F. igniarius* concluded from a consideration of the similarity of cultures and the association of the sterile conks and normal *F. igniarius* sporophores on the same tree that the two were the same. Campbell (**3**) described the cultural characteristics of a considerable number of species of *Fomes*, including the sterile fungus from birch and demonstrated that cultures of this

fungus, which he called the sterile *Fomes*, could be readily separated from all the other species studied.[1]

In August 1937, a brown *Poria* was collected on an 8-inch, badly decayed, standing, yellow birch snag in the October Mountain State Forest, Massachusetts. This *Poria* had developed under the last annual layer of wood and on maturing had split the bark and thin wood layer outward partially exposing the sporophore. In this particular case the fungus had fruited on one side of the snag, for its entire length, about 12 feet, and had also developed in a similar manner on the lower side of the broken portion on the ground. An extensive search in the area and later in the Harvard Forest showed this *Poria* to be common on dead standing, much decayed, yellow and white birch trunks, but only on those trunks bearing sterile conks. This suggested a possible relationship between the *Poria* and the sterile conks. Specimens of the former were sent to the Division of Forest Pathology laboratory at Washington for culturing. Sporophore and spore isolations yielded a fungus identical with that obtained from the sterile conks and from the decay associated with them, proving without question that this *Poria* was the fruiting stage of the fungus causing the sterile conks on birch.

THE DEVELOPMENT OF THE PORIA

Both the sterile conks and the *Poria* are common in certain areas in New England, especially in middle-aged stands of badly ice-damaged and cankered yellow or white birch. Infection evidently takes place through trunk and top wounds, branch stubs and old, open *Nectria* cankers. The fungus causes a well-defined heart rot which extends up and down the trunk, but which is prevented by the sapwood from developing to any great extent radially. In time a sterile conk, composed of brown, short-celled, parallel hyphae, which appear as pseudoparenchyma cells in cross-section,

[1] Dr. L. O. Overholts, in a letter, stated that Dr. Irene Mounce first drew his attention to the spores produced in culture by the sterile fungus. He informed her at the time that the spores did not conform to any described species of *Fomes* and that the fungus on the basis of spores could not be *F. igniarius*. The authors' original conception of the lack of relationship between cultures of the sterile fungus and *F. igniarius* was in a large measure a result of contact with Dr. Overholts.

forms presumably at the point of entry and often at other places on the trunk where the fungus is able to penetrate the encircling sapwood layer. The sterile conks seem to increase in size from year to year, sometimes reaching a foot or more in diameter. At first the sterile conk is a rich yellowish-brown, but the outer portion soon blackens and hardens until the whole structure becomes a dark, cracked, clinker-like mass (FIG. 1, *A*). As the decay progresses and the tree gradually weakens, breakage often occurs, usually at a point where a sterile conk has formed (FIG. 1, *B*).

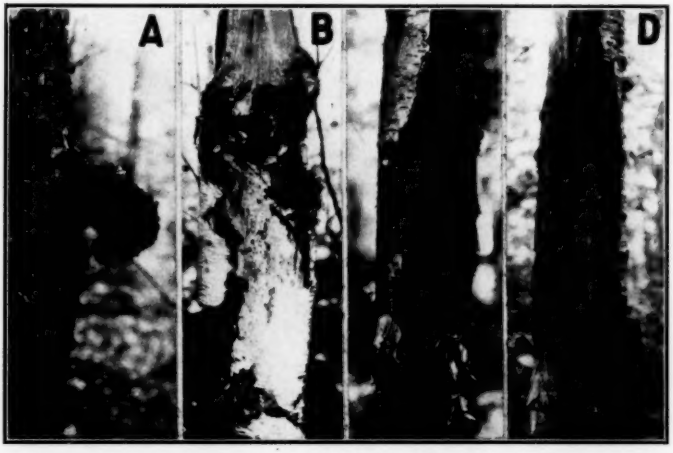

FIG. 1. *A*, sterile conk on yellow birch; *B*, paper birch broken at point where sterile conk had formed; *Poria* fruiting below break. *C*, *Poria*, showing splitting of bark; *D*, old *Poria*.

After the tree is dead the sterile conk soon ceases to enlarge. The fungus in the center grows outward through the dead sapwood. In 2 or 3 years it forms a thin dark-brown layer, composed of the same type of hyphal cells as found in the sterile conk, at varying depths from 1 to several millimeters in the wood. This hyphal layer develops into the brown *Poria*, which splits open the bark at maturity leaving the fungus in a position to shed spores (FIG. 1, *C*). By that time the standing snag is badly decayed and often the sterile conks have weathered so completely as to be scarcely noticeable. Insects attack the sporophore as soon as it bursts through

the bark and soon cause its complete disintegration. By the time the bark flap has fallen aside all that remain of the *Poria* are some irregular patches on the brown-stained, hardened, wood surface (FIG. 1, *D*).

Judging from the condition of the specimens located during the latter part of the season, most of the fruiting takes place early in the summer. However, the fungus may fruit until October as freshly developed sporophores were found at that time.

Some direct data as to the time required for the *Poria* to develop on a dead birch trunk heart-rotted by the fungus were afforded by observations on a yellow birch from which Overholts and Campbell collected a sterile conk in October 1934. This tree located in northern Pennsylvania was alive at the time the collection was made but was cut during the winter of 1934. On relocating the tree in November 1937, the *Poria* was found fruiting, in good condition, the entire length of the down portion and also on the 2-foot stump.

NOMENCLATURE

At present it is impossible to definitely identify this *Poria*. L. O. Overholts, who examined the *Poria* specimens, stated that the fungus, on the basis of herbarium material examined up to the present time, belongs to the *Poria obliqua* (Pers.) Bres. complex, which may be composed of several species. Further investigations will be needed to determine whether or not more than one species is involved under that name in the literature. Skoric (**7**) reviewed the literature dealing with *P. obliqua* and applied the name, following Bourdot and Galzin (**2**), to a fungus found on oaks in Europe. His descriptions are fairly complete so a comparison between the oak fungus of Europe and the birch fungus of America is possible. Skoric's oak fungus fruits only in hollowed-out places in living trunks and has prominent setal hyphae up to 15 μ in diameter in the trama, in the sterile nodules, and in cultures. The birch fungus fruits under the bark and thin wood layer of dead trees, does not have readily demonstratable setal hyphae in the trama and in culture forms smaller setal hyphae rarely over 7–8 μ in diameter. The spores of the two fungi are practically the same

in size and shape. Baxter (1) referred *Poria obliqua* to *Polyporus glomeratus.*

Further study of *P. obliqua* in Europe together with examination of type specimens will be required before any satisfactory disposition as to name can be made. It seems fairly certain however that the *P. obliqua*-like fungus which occurs on birches in Sweden and Russia (7) is the same as the one in America.

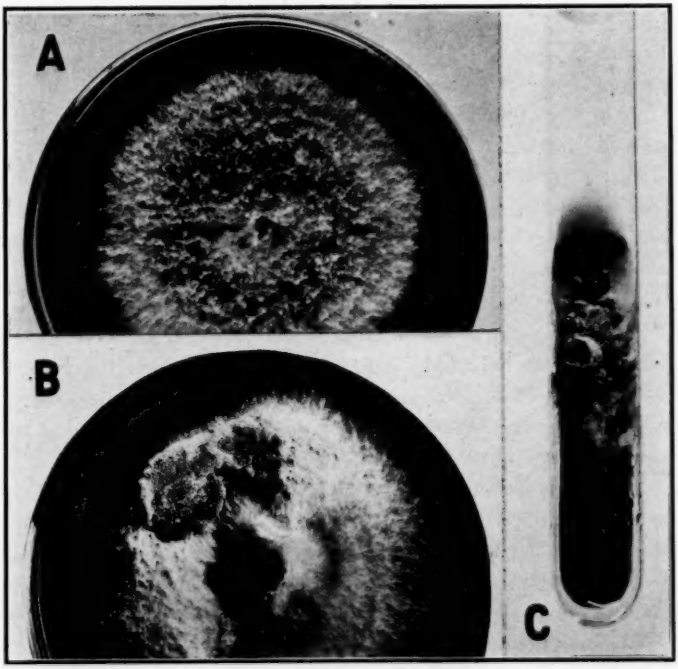

FIG. 2. *A*, 14-day-old culture; *B*, 21-day-old culture showing sporophore produced on surface of mat; *C*, 6-week-old culture showing sporophore.

DESCRIPTION OF PORIA SPECIES

Sporophore developing at irregular depths in the dead sapwood, often extending many feet up and down the trunk, at first yellow, moist, somewhat coriaceous, then dry, brittle, dark-brown with pore mouths covered with whitish or yellowish hyphal outgrowths.

Tubes underlaid with a subiculum composed of dark brown, septate, parallel hyphae and varying in thickness from 1 to several millimeters under center to as much as 3 cm. at the margins. Pore layer 2–10 mm. thick with pores oblique, about 3 per mm.

Basidia subglobose to short clavate 6–10 μ broad, 2 or 4-spored; basidiospores hyaline or slightly yellowish, mostly 1-guttulate, subglobose to elliptical 6–10 $\times$ 4–6 μ; bulbous setae with points dark brown, thickened, and bases thin, almost hyaline, abundant to rare in hymenium, varying in length and from 6–9 μ in diameter; setal hyphae lacking or rare in context and trama, most abundant near the mouths of the tubes.

Occurrence: Collected to date on dead standing snags or limbs of *Betula lenta* L., *B. lutea* Michaux, *B. papyrifera* Marshall, and *B. populifolia* Marsh in Mass., Penn., N. H., and Vt. Sterile conks have been collected on *Alnus* and *Ostrya* at various points and it is possible that this *Poria* will be found on these hosts as well as on *Betula*. A similar fungus, not in culturable condition, was found on *Fagus* in Pennsylvania.

Description of cultures: [2] Growth slow, variable, in Petri dishes forming a mat 1–4 cm. in diameter at room temperature in 7 days. Mat usually white but occasionally yellowish or cream-colored about the center, raised cottony or silky-cottony to somewhat appressed felty-cottony.

In 14 days mat 3–7 cm. in diameter, thin or thick, white cottony or silky-cottony to cream color, Naples yellow or cinnamon buff,[3] compacted, felty-cottony, homogeneous, azonate or definitely zoned with a yellowish or brownish crust next to the agar; margin white cottony, fimbriate (FIG. 2, *A*).

In 21 days mat more compacted, usually definitely yellowish with brown staled areas under the mat. Irregular well-defined or very abortive yellowish or wood-colored poroid areas formed on the surface, becoming more distinct in 28 days (FIG. 2, *B*).

Submerged nutritive hyphae and white aerial hyphae thin-walled, branched, sparsely septate, without clamps, 2–6 μ in diam-

[2] All descriptions based on mats grown on 1.5 per cent Difco malt with 2 per cent agar, in diffused light, inoculum 2 mm. square.

[3] Ridgway, R. Color standards and nomenclature. 1912.

eter gradually grading into yellowish, many septate hyphae in older portions of the mat (FIG. 3, *A*); fibrous thick-walled, dark-brown hyphae 2–3 μ in diameter common in some cultures, rare in others; setal hyphae, dark-brown with thick walls common in most isolations, up to 250 μ long and 5–8 μ in diameter (FIG. 3, *B*); short bulbous setae common in hymenial layers formed in culture and on surface of compacted areas 7–10 μ in diameter (FIG. 3, *C*); basidia 2- or 4-spored, subglobose to short clavate 6–9 μ in diam-

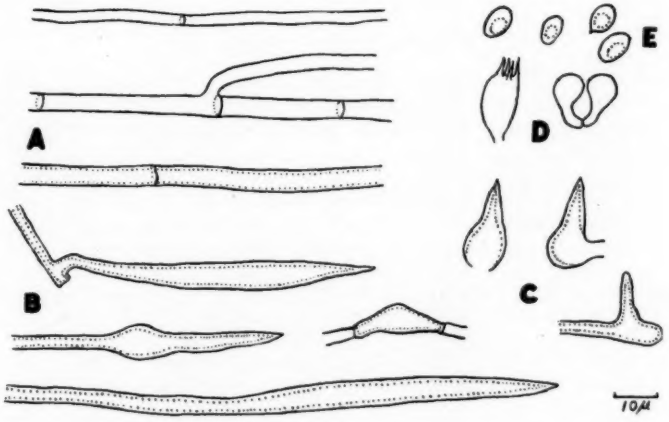

FIG. 3. Microscopic characters of *Poria* in culture. *A*, hyphae; *B*, setal hyphae; *C*, setae from hymenium; *D*, basidia; *E*, basidiospores.

eter (FIG. 3, *D*); basidiospores subglobose to ellipsoid mostly 1-guttulate, hyaline or pale-yellowish 6–10 × 4–6 μ (FIG. 3, *E*).

Test-tube cultures: Mat mostly white cottony for first 7 days becoming when aged cream color to Naples yellow or darker, appressed with a brown staled area under the surface. Most isolations fruit within 4 to 6 weeks forming well-defined wood-colored or yellowish sporophores (FIG. 2, *C*).

Temperature relations: Optimum temperature for growth about 25° C. Average diameters of mats in 7 days, in dark, at constant temperatures as follows: 1.6 cm., 20°; 2.4 cm., 25°; 1.8 cm., 30°; trace, 35°; 0, 40°.

Single-spore cultures: Single-spore cultures showed much variation in growth rate and appearance, but no more than noticed for the rot isolates as a group. Out of 8 single-spore cultures 5 fruited in test tubes in 6–8 weeks. Both appearance and microscopic characters of the single-spore cultures were the same as those from other sources.

CIVILIAN CONSERVATION CORPS AND
DIVISION OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE.

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SPHACELOMA ROSARUM AS GLOEOSPORIUM ROSAECOLA

JOHN DEARNESS

(WITH 1 FIGURE)

At Stockton, Kansas, in August, 1928, the late Dr. Elam Bartholomew collected a quantity of rose leaves of cultivated varieties, injured by a parasitic fungus. He wrote to me that he had observed it in Stockton gardens in previous years, but had not identified it.

In the upper surface of small, whitish, red-bordered spots on leaves and petioles we found minute sporing pustules, nearly like

FIG. 1. *Sphaceloma rosarum* on rose leaflets, Kansas, 1928, E. Bartholomew, × 1. Photograph made by Dept. Plant Pathology, Cornell Univ.

Gloeosporium, but with the covering cuticle somewhat modified. The literature of melanconiaceous parasites on Rosaceae afforded no applicable description. One was written with the title "*Gloeosporium rosaecola* Dearn. & Barth.," but not published at the time. Specimens were sent to some of our correspondents and in the 1930 list of "Additions to the Fungus Flora of Kansas"[1] this name was printed.

In 1932 Dr. Anna E. Jenkins published her discovery that the

[1] Bartholomew, E. Additions to the Fungus Flora of Kansas. Trans. Kans. Acad. Sci. **33**: 82–83. 1930.

type of *Phyllosticta rosarum* Pass. is a *Sphaceloma*.[2] In reading her report the writer of this note suspected that the Stockton fungus is this species and sent her some of the affected leaves. She confirmed his suspicion that "E. B. *10343*" is *Sphaceloma rosarum* (Pass.) Jenkins, the first and at the time the only American record (FIG. 1).

The late Mr. W. B. Grove accepted Dr. Jenkins' finding, but thought that the housing was not of generic importance so he called it *Gloeosporium rosarum* (Pass.).[3] He added that the disease was first noticed in England in 1926 and that it was spreading.

LONDON, ONTARIO, CANADA

[2] Jenkins, A. E. Rose anthracnose caused by Sphaceloma. Jour. Agr. Res. **45**: 321–337. 1932.

[3] Grove, W. B. British Stem and Leaf Fungi **2**: 224. 1937.

SPECIES OF TAPHRINA ON NORTH AMERICAN FERNS

A. J. Mix

(WITH 3 FIGURES)

Following the discovery (reported below) of a new species of *Taphrina* on *Cystopteris fragilis* (L.) Bernh., a study was undertaken of representatives of this genus found on native ferns. This study has extended to examination of material in the larger mycological herbaria of the United States and Canada. It is believed to be sufficiently complete to indicate the known distribution of North American species.

The study has been made possible by the kindness of American mycologists in placing material at the writer's disposal. Some of these mycologists are mentioned in the text, and to all of them grateful acknowledgment is hereby made.

It is not possible to predict that every decision here made will prove to be correct. It is often difficult to decide whether a given fungus is a new species or should be assigned to a species already known. In the past newly found forms of *Taphrina* on new fern-hosts have usually been described as new species. This would seem a safe procedure if the fungus shows morphological differences from known species or, in the case of similar fungi, if the fern-hosts are distantly related. It is probable that morphologically similar fungi on closely related ferns belong to the same species, and in such cases cross-inoculation experiments would be desirable. Of the species discussed here two: *Taphrina Hiratsukae* Nishida and *T. Struthiopteridis* Nishida are morphologically similar, induce similar lesions, and occur on related ferns. It would be desirable to attempt transfer of these fungi from the one host to the other. In none of the other cases does cross inoculation seem so necessary, although it would, of course, be desirable.

An account follows of the known species of *Taphrina* on North American ferns, arranged under their respective hosts. The order

of presentation of host species and the host nomenclature followed is that of Small (**11**), important synonyms being given in all cases.

THELYPTERIS THELYPTERIS (L.) Nieuwl. (*Acrostichum thelypteris* L. *Dryopteris thelypteris* (L.) A. Gray.) Marsh Fern.

1. *Taphrina lutescens* Rostr.

This fungus causes roundish or irregular yellow-brown spots on the leaves of its host. The spots are often limited by the small veins. The leaf-blade is not thickened, and the asci occupy only the central portion of the spot leaving a marginal discolored area free. In these respects the lesions resemble those caused by *T. Hiratsukae* and *T. Struthiopteridis* reported below.

The asci, borne on the under surface of the leaf, are clavate, and lack a stalk cell. They are smaller than those of the original Danish form as described by Rostrup (**9**), but European forms with asci of intermediate size occur.

The differences in ascus-size between American and European specimens examined is as follows.

a. Specimen in the Farlow Herbarium, collected by Rostrup, July, 1889, at Gjorslev, Saeland, Denmark. (Apparently a part of Rostrup's type collection.) Asci 60–75 $\mu \times$ 8–10 μ. (These are the exact dimensions published by Rostrup.) Spores 2.5–5 $\mu \times 2.5\ \mu$.

b. Kirulis, A. Fungi Latvici *632*. Milskabe, Prov. Leinzale, Latvia. Aug. 5, 1934. Asci 50–73 $\mu \times$ 8–11 μ.

c. Jaap, O. Fungi selecti exsiccati *304*, Pugum, near Glücksberg. July 13, 1908. Asci 43–56 $\mu \times$ 6–10 μ.

d. Farlow Herbarium. Shelter Island, N. Y. Aug., 1901. W. G. Farlow. Asci 27–53 $\mu \times$ 5–9 μ. Spores 3–6 $\mu \times$ 3–4 μ.

e. Farlow Herbarium. York, Maine, Aug. 12, 1897. R. Thaxter. Asci 30–40 $\mu \times$ 5–7 μ. Spores 4–6 $\mu \times$ 2.5–3.5 μ (see FIG. 2, *A*).

There can be no question that these collections are all of the same fungus, since the asci are quite similar, the host is the same, and the host-lesions identical. Ascospores are rare in all speci-

mens, the asci usually containing numerous bacterioid conidia. These agree in size with the measurements originally given by Rostrup (4–5 $\mu \times$ 0.5–1 μ).

From these observations the original description of *Taphrina lutescens* must be modified to the following extent: Asci 27–75 $\mu \times$ 5–11 μ, spores 3–6 $\mu \times$ 2.5–4 μ.

Distribution: Besides its occurrence in Europe, the fungus is known in North America from the two localities named above, and also from Minneapolis (state?), August, 1873 (W. G. Farlow?). Specimen in the Farlow Herbarium.

DRYOPTERIS ARGUTA (Kaulf.) Wats. Coastal Wood Fern.

2. **Taphrina californica** sp. nov.

Mycelio in loculis in muris cellularum epidermidis crescente; ascis amphigenis, e loculis erumpentibus, dense confertis, clavatis, apice rotundatis vel truncatis, 23–36 μ longis $\times$ 7–8 μ crassis, cellula basilari cylindracea 17–30 $\mu \times$ 5–7 μ, ascosporis globosis vel ellipticis, 4–5 $\mu \times$ 2–3 μ. Tumores brunneos gignens in foliis *Dryopteridis argutae* (Kaulf.) Wats.

Hymenium amphigenous, asci at maturity emerging from locules in outer walls of the epidermal cells of the gall, close packed, clavate, rounded or truncate at apex, 23–36 $\mu \times$ 7–8 μ, stalk cells cylindric, 17–30 $\mu \times$ 5–7 μ, ascospores round or elliptic, 4–5 $\mu \times$ 2–3 μ. Developing with wall-locules, filling them with a close packed layer of ascogenous cells which later elongate to asci. Causing brownish, fleshy galls on leaves of *Dryopteris arguta* (Kaulf.) Wats. Marin County, California, August 21, 1930, V Duran; September 4, 1930, H. E. Parks (California Fungi *343*); November 28, 1937, L. Bonar.

Type material in Mycological Herbarium, University of Kansas

This fungus was collected at Lake Phenix, Marin County, California, September 4, 1930, by H. E. Parks, and distributed under the name *Taphrina filicina* (California Fungi *343*). Specimens from several packets from this collection, and from another collection made in the same locality, August 21, 1930, by Victor Duran, have been examined. In all these the fungus is immature, showing ascogenous cells but no asci. Dr. Lee Bonar, of the University of California, was kind enough to make a special collection on November 28, 1937. In this material the fungus is

for the most part over-mature, but mature asci and spores can easily be seen.

This fungus induces small brown galls, much hypertrophied, on the leaves. The aggregation of a number of galls close together helps to make their appearance prominent (FIG. 1). The galls may originate on either surface of the leaf.

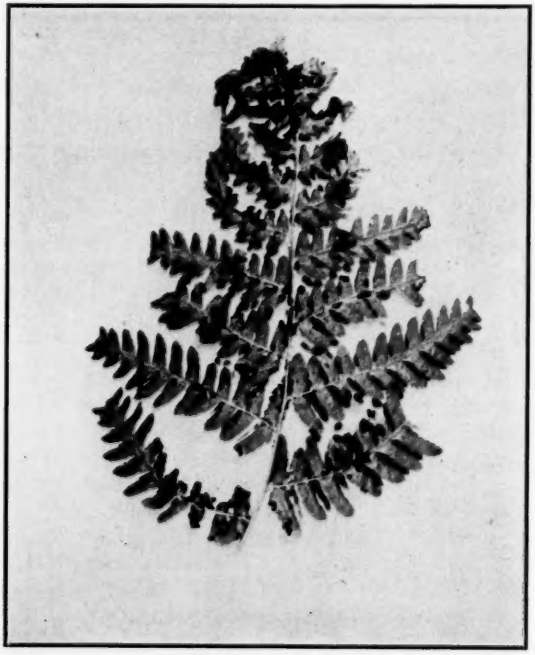

FIG. 1. Galls caused by *Taphrina californica* on leaves of *Dryopteris arguta* (Kaulf.) Wats. × ¾.

Large locules in the outer walls of the epidermal cells of the gall are filled with ascogenous cells of the fungus (FIG. 2, *B*) and at maturity the asci burst out of these locules, protruding from them as from perithecia (FIG. 2, *C*). The appearance is as though the fungus had developed within the epidermal cells.[1]

[1] The reasons for concluding that this fungus occupies locules in the walls rather than occurring in the epidermal cells themselves will be given in a subsequent paper, in which the nature of the gall will be more fully described.

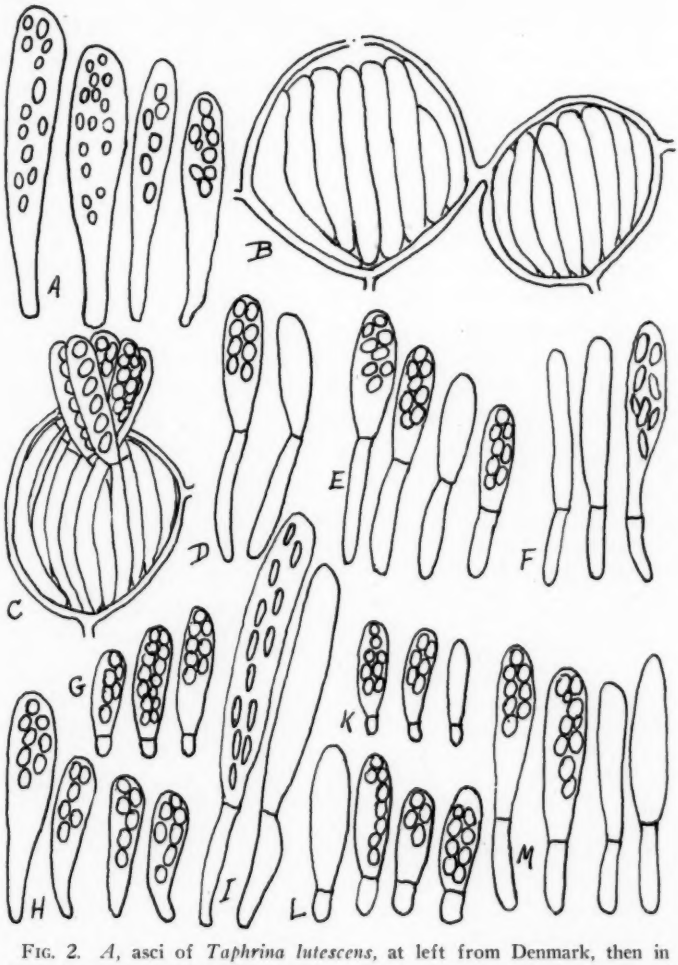

FIG. 2. *A*, asci of *Taphrina lutescens*, at left from Denmark, then in order from Latvia, Germany, America; *B*, ascogenous cells and *C*, asci of *T. californica* in epidermal locules of host; *D*, asci of *T. californica*. Asci, *E* of *T. fusca*; *F*, *T. gracilis*; *G*, *T. Hiratsukae*; *H*, *T. filicina*; *I*, *T. Faulliana*; *K*, *T. Struthiopteridis*; *L*, *T. Cystopteridis*; *M*, *T. Polystichi*, × 800.

The only known species with a similar habit is *Taphrina laurencia* Giesenhag. on *Pteris quadriaurita* Retz in Nepal and Ceylon. This fungus is described by Giesenhagen (**2**) as occurring in the outer portion of an epidermal cell, being separated from the host-protoplasm by a thin cellulose membrane. *Taphrina laurencia* causes very large, much branched, bushy outgrowths on the leaves of its host, entirely different from the galls produced by the California fungus. The asci of the two fungi are alike in size, *T. laurencia* having asci 24 $\mu \times$ 6–7 μ, stalk cells 19 $\mu \times$ 6–7 μ, and *T. californica* asci 23–36 $\mu \times$ 7–8 μ, stalk cells 17–30 $\mu \times$ 5–7 μ (FIG. 2, *D*) but differences in host-relations and in the nature of the galls seem sufficient to separate them.

DRYOPTERIS MARGINALIS (L.) A. Gray (*Aspidium marginale* (L.) Sw.) Marginal Shield Fern.

3. **Taphrina gracilis** sp. nov.

Ascis primo hypophyllis, secundo epiphyllis, dense confertis, clavatis, tenuibus, apice rotundatis, 26–36 μ longis $\times$ 4–6 μ crassis, cellula basilari cylindracea, 13–23 $\mu \times$ 3–4 μ, in matricem non penetrante; mycelio inter cuticulam epidermidemque utraeque paginae foliorum crescente; ascosporis elongatis-ellipticis aut fusoideis, 5–8 $\mu \times$ 2–2.5 μ. Bullas parvas, subflavas aut brunneas, in foliis *Dryopteridis marginalis* (L.) A. Gray gignens.

Hymenium hypophyllous, later epiphyllous, asci crowded, clavate, slender, rounded at apex, 26–36 $\mu \times$ 4–6 μ; stalk cells cylindric, seated on epidermis, not inserted, 13–23 $\mu \times$ 3–4 μ; spores long-elliptic to fusiform, 5–8 $\mu \times$ 2–2.5 μ. Causing small yellowish to brown thickened spots on leaves of *Dryopteris marginalis* (L.) A. Gray. Labrador Lake, Apuleia, near Ithaca, New York, June 2–7, 1919, E. W. Olive, H. H. Whetzel, et al.

Type material (scanty) in Herbarium of New York Botanic Garden.

Two collections of a fungus identified as *Taphrina filicina* on *Dryopteris marginalis* exist in the herbarium of the Department of Plant Pathology of Cornell University. One of these, No. *10685*, was made at Enfield, near Ithaca, New York, the other, No. *1256*, at Labrador Lake, Apuleia, New York, June 2–7, 1919, by E. W. Olive, H. H. Whetzel et al. Both are reported (in correspondence) by Mr. W. W. Ray, Assistant Mycologist at Cornell University, as "not good for taxonomic purposes."

Duplicate material of No. *1256* in the Brooklyn Botanic Garden (received from Dr. George M. Reed) shows a few lesions in which subcuticular mycelium and ascogenous cells may be seen but no asci. Material in The New York Botanical Garden (received from Dr. F. J. Seaver) shows a very few lesions with mature asci. The material is small in amount, and it is regrettable that a new species must be described with so little type material remaining for examination by other workers. However, the few lesions present are in excellent condition and the characters of the fungus are easily recognizable.

The spots are small (about ½ cm. in diameter) yellow-brown (in the dried state), moderately thickened, and resembling somewhat small lesions produced on the peach leaf by the well-known curl fungus. Microscopically the gall resembles that caused by *Taphrina filicina*, in that all of the leaf cells are more or less enlarged, no proliferation of epidermal cells, as induced by *T. fusca*, being evident. In the specimens examined the asci are borne on the under surface of the leaf, but a subcuticular hymenium with ascogenous cells and immature asci is present on the upper surface. The asci (with stalk cells) are more slender than those of other known species on ferns, and the ascospores (not usually of diagnostic value in species of *Taphrina*) are long-oval to almost spindle-shaped (FIG. 2, *F*).

DRYOPTERIS SPINULOSA (Muell.) Kuntze. (*Aspidium spinulosum* (Muell.) Sw.) Spinulose Shield Fern.

4. *Taphrina fusca* Giesenhag.

This fungus causes small (2 to 8 mm. in diameter), fleshy, cream-color or pale-yellow tumors on leaves. The asci measure 19–27 $\mu \times$ 5–7 μ, stalk cells 25–34 $\mu \times$ 4–6 μ, spores 4–6 $\mu \times$ 2–3 μ. The stalk cell is variable in length and may be longer than the ascus proper (FIG. 2, *E*).

Taphrina fusca was described by Giesenhagen (3) as occurring on *Aspidium pallidum* Link, in Albania and Sicily. Giesenhagen gives dimensions of asci as 20–24 $\mu \times$ 5–7 μ. He does not state dimensions of stalk cells, but from his figure, which is drawn to scale, it may be calculated that stalk cells occur which are 23 μ,

30 μ, or 33 $\mu \times 5$ μ. Giesenhagen makes a diagnostic feature of the histological character of the gall, which originates from the upper epidermis, and consists of long thin-walled host-cells covered by a close packed subcuticular layer of ascogenous cells of the fungus. The gall on *Dryopteris spinulosa* agrees closely with Giesenhagen's description and illustration.

There can be little doubt that, in spite of their occurrence on different hosts, these two fungi should be considered identical. Even if it should prove that they are not transferable from the one host to the other, the distinction between them would be biological only. Morphologically they are quite similar.

Distribution: This fungus is known in North America from the following collections:

On *Dryopteris spinulosa* (Muell.) Kuntze. The collections are so labelled, and it is impossible to determine the host-species from lack of fruiting fronds, but it may well be that these specimens are all *Dryopteris spinulosa* (Muell.) Kuntze. var. *intermedia* Underw. 1. Bayard, West Virginia, July, 1891, W. C. Sturgis (in Farlow Herbarium). 2. Campobello, New Brunswick, July, 1902, W. G. Farlow (in Farlow Herbarium). 3. Mount Lafayette, New Hampshire, July 19, 1935, D. H. Linder (in Farlow Herbarium, and Herbarium of the University of Kansas).

On *Dryopteris spinulosa* (Muell.) Kuntze, var. *americana* (Fisch.) Fernald. 1. Mt. Mansfield, Vermont, July 15, 1932, J. H. Faull and K. S. Chester (Herbarium of J. H. Faull, No. *10734*).

On *Dryopteris spinulosa* (Muell.) Kuntze, var. *intermedia* Underw. 1. Tuckerman Ravine Trail, Mt. Washington, New Hampshire, July 6, 1931, J. H. Faull, and K. S. Chester (Herbarium of J. H. Faull, No. *9934*).

5. *Taphrina filicina* Rostr.

This fungus is known only from the vicinity of Ithaca, New York, although a number of collections of other species of *Taphrina* on other fern-hosts have been wrongly identified as *T. filicina*. For first knowledge of the occurrence of this species near Ithaca, the writer is indebted to W. W. Ray of Cornell Uni-

versity. Besides material collected by Mr. Ray, two other collections have been examined, one made at Enfield Gorge, July 14, 1917, by J. H. Faull (Herbarium of J. H. Faull No. *1804*), the other at Coy Glen by L. B. Walker, July 3, 1927.

Taphrina filicina lacks a stalk cell. The description as given by Johanson (**6**) is: Asci amphigenous, clavate, rounded at apex, 29–38 $\mu \times$ 5–9 μ, attenuate at base to a width of 3.5 to 4.5 μ; spores 4–5 $\mu \times 2\ \mu$. Jankowska (**5**) gives dimensions of asci as 27–33 $\mu \times$ 6–9 μ. In exsiccati material examined by the writer (Jaczewski, Komarov, Tranzschel. Fungi Rossiae Exsiccati No. 27. Beresaika, Prov. Novgorod. July, 1890. W. Tranzschel) the asci measure 33–46 $\mu \times$ 7–10 μ, spores 5–6 $\mu \times$ 2–3.5 μ. In the American specimens the asci are 18–27 $\mu \times$ 6–8 μ, spores 3.5–5 $\mu \times$ 2–3 μ (FIG. 2, *A*). The American fungus appears considerably smaller than the European and might perhaps be designated as an American variety, but from the observations as to variability in ascus size of *Taphrina lutescens* (reported above) it is believed that the size-differences in *T. filicina* would disappear if more material were examined. The galls produced by this fungus are small (3 mm. or less in diameter), fleshy, cream-colored or yellowish. Microscopically they present a contrast to those caused by *T. fusca,* in that they are not epidermal in origin, but show hypertrophy of all leaf-tissues. This difference was pointed out by Giesenhagen (**3**).

As in the preceding case difficulty is experienced in deciding as to the host-species, but it may be that the American form of this fungus occurs on both *Dryopteris spinulosa* and on *D. spinulosa* var. *intermedia.*

POLYSTICHUM ACROSTICHOIDES (Michx.) Schott. Christmas Fern.

6. **Taphrina Polystichi** sp. nov.

Ascis epiphyllis, dense confertis, clavatis, apice rotundatis, 30–46 μ longis $\times$ 4.5–7.5 μ crassis, cellula basilari cylindracea, 15–23 $\mu \times$ 4–6 μ, in matricem non penetrante; mycelio inter cuticulam epidermidemque utraeque paginae foliorum crescente; ascosporis saepe octonis, ellipticis, 3–6 $\mu \times$ 2–4 μ. Maculas magnas crassescentes, subflavas vel albo-pruinatas, in foliis *Polystichi acrostichoidis* (Michx.) Schott. gignens.

Hymenium epiphyllous, asci crowded, clavate, rounded at apex, 30–46 $\mu \times$ 4.5–7.5 μ, stalk cells cylindric, 15–23 $\mu \times$ 4–6 μ, seated

on epidermis, not inserted, close subcuticular layer of ascogenous cells on both sides of leaf but producing asci only on upper surface, ascospores elliptic, 3–6 $\mu \times$ 2–4 μ. Causing large thickened, yellowish or whitish spots on leaves of *Polystichum acrostichoides* (Michx.) Schott.

Distribution: Eastern North America. Type material in Mycological Herbarium, University of Kansas.

The fungus on the Christmas fern, *Polystichum acrostichoides* (Michx.) Schott was first collected at Bayard, West Virginia, July, 1891, by W. C. Sturgis (specimens in the Farlow Herbarium). It was described by Coker (1) in 1910 from material collected at Chapel Hill, North Carolina, and called *Exoascus filicinus* (Rostr.) Sacc. It is represented in many herbaria and has been collected in New Brunswick, Nova Scotia, Ontario, Maine, Massachusetts, Connecticut, New York, Ohio, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, and Tennessee. Perhaps its range may eventually prove to coincide with that of its host.

Material of the *Polystichum*-fungus first studied was received in 1935 from H. D. House and F. A. Wolf. House's collection was made at Oneida, New York, and Wolf's at Durham, North Carolina. The description here given is based primarily on these specimens, but comparative studies have also been made of Sturgis' West Virginia material and specimens from Hamilton County, Ohio (Wm. Bridge Cook); Cades Cove, Tennessee (L. R. Hesler); Trout Run, Pennsylvania (L. O. Overholts); and from many other localities. Coker's specimen has not been seen. (Dr. Coker stated, in correspondence, that his original material had been lost. What is probably a part of that collection is in the herbarium of The New York Botanic Garden.)

This fungus causes rather large (½ to 1 cm.), swollen, yellowish spots on leaves. The asci are epiphyllous, sometimes also hypophyllous, close packed, 30–46 $\mu \times$ 4.5–7.5 μ. The stalk cells are 15–23 $\mu \times$ 4–6 μ. Ascospores measure 3–6 $\mu \times$ 2–4 μ (FIG. 2, *M*).

The fungus differs in size of asci and stalk cells from any described species of *Taphrina* on ferns. It cannot be *Taphrina filicina* since that fungus has no stalk cell.

POLYSTICHUM MUNITUM (Kaulf.) Presl. Sword Fern.

7. **Taphrina Faulliana** sp. nov.

Hymenio hypophyllo, ascis dense confertis, clavatis, apice rotundatis 43–76 μ longis $\times$ 4–7 μ crassis, cellula basilari cylindracea, 13–33 $\mu \times$ 5–7 μ, ascosporis nondum visis, conidiis numerosis, 5–6 $\mu \times$ 1.5 μ; mycelio inter cuticulam epidermidemque inferioris paginae foliorum crescente. Maculas parvas brunneas gignens in foliis *Polystichi muniti* (Kaulf.) Presl. Haud deformans.

Asci hypophyllous, close packed, slender-clavate, rounded at apex, 43–76 $\mu \times$ 4–7 μ, stalk cell cylindric, variable in length, 13–33 $\mu \times$ 5–7 μ, ascospores not present in type specimen, conidia numerous, bacterioid, 5–6 $\mu \times$ 1.5 μ, mycelium subcuticular. Causing small brown spots on leaves of *Polystichum munitum* (Kaulf.) Presl., with no thickening of leaf tissues.

Rhododendron, Oregon, September 6, 1931. J. H. Faull. Type material: Herbarium of J. H. Faull, No. *10162*.

The only known collection of this fungus was made at Rhododendron, Oregon, September 6, 1931, by J. H. Faull. It causes small (up to 5 mm. in diameter) roundish or elliptic, brown spots on the leaves. There is no thickening of leaf-tissue in the affected areas, and apparently the mycelium is subcuticular only. The asci are long, 43–76 $\mu \times$ 7–8 μ, with long stalk cells, 13–33 $\mu \times$ 5–7 μ (FIG. 2, *1*). Ascospores have not been seen, all of the asci examined containing numerous bacterioid conidia, 5–6 $\mu \times$ 1.5 μ.

This species shows important differences from any previously described form on ferns. Asci of comparable length (50–70 μ) are formed by *Taphrina fasciculata* (Lagerh. and Sadeb.) Giesenhag. occurring on "*Nephrodium sp.*" in Ecuador, but the asci of that fungus are broader (9–12 μ) and according to Sadebeck (**10**) are shaped like those of *Taphrina potentillae*. Spores of *T. fasciculata* are 5–8 $\mu \times$ 4μ and do not readily bud within the ascus. Another species that may be more closely related to the one on *Polystichum munitum* is *Taphrina Wettsteiniana* Herzf. on *Polystichum lonchitis* (L.) Roth. This fungus causes bladdery swellings on the leaves of its host, forms intercellular mycelium, with consequent enlargement of leaf cells, and the asci are variable as to presence of stalk cell. The asci of *T. Wettsteiniana* are 50–70 μ long, including the stalk cell which may be

one-third as long as the ascus proper. They are thus considerably shorter than those of the fungus under discussion.

CYSTOPTERIS FRAGILIS (L.) Bernh.

8. **Taphrina Cystopteridis** sp. nov.

Ascis epiphyllis, aliquando amphigenis, dense confertis, clavatis, apice rotundatis, 20–30 μ longis $\times$ 4–7 μ crassis, cellula basilari cylindracea 8–15 μ $\times$ 4–6 μ, in matricem non penetrante, mycelio inter cuticulam epidermidemque crescente; ascosporis saepe octonis, globosis vel ellipticis, 3–6 μ $\times$ 2–3 μ. Bullas gignens, parvas (0.5 mm.–2.0 mm.), primo virides, in aetate brunneas, in foliis *Cystopteridis fragilis* (L.) Bernh.

Hymenium epiphyllous, occasionally also hypophyllous, asci close together, clavate, with rounded apex, 20–30 μ $\times$ 4–7 μ, with cylindric stalk cells 8–15 μ $\times$ 4–6 μ, arising from close layer of ascogenous cells between cuticle and epidermis, seated on epidermis, not inserted, ascospores globose or elliptic 3–6 μ $\times$ 2–3 μ. Causing small (0.5–2.0 mm.), swollen spots, at first greenish, becoming brown, on leaves of *Cystopteris fragilis* (L.) Bernh. Neodesha, Kansas. June, 1936. W. H. Horr.

Type material in Mycological Herbarium, University of Kansas.

The first specimen of this fungus seen was collected in June, 1936, at Neodesha, Kansas, by Dr. W. H. Horr of the Department of Botany, University of Kansas. Other specimens studied are: Flora of Indiana, No. *35595*, Greencastle, May 23, 1922; ibid. No. *38665*, Glendale, Daviess County, June 4, 1923, both collections by C. C. Deam; and University of Wisconsin Herbarium, specimen collected by J. J. Davis at Brodhead, Wisconsin, September 16, 1926. All these agree with the type-specimen, and from these collections it appears that the fungus may be widely distributed, if not common, in the upper Mississippi valley.

The fungus produces on the leaves small galls (from 0.5 mm. to 2.0 mm. in diameter), round or irregular in outline, and much thickened and swollen. Young galls are greenish, with a smooth surface. At maturity of asci they are covered with a whitish bloom, and the surface may develop wrinkles and folds. After the asci have emptied, the spots become dark-brown and shrunken. The appearance of ascus-bearing lesions is shown in figure 3.

The asci are most commonly borne on the upper epidermis, but some spots, especially those occurring at leaf margins, show them also on the lower surface.

The asci are clavate, rounded at the apex, and provided with a stalk cell. Dimensions are: asci 20–30 $\mu \times$ 4–7 μ, stalk cells 8–15 $\mu \times$ 4–6 μ, spores 3–6 $\mu \times$ 2–3.5 μ (FIG. 2, *L*). These dimensions do not agree closely with those of any previously de-

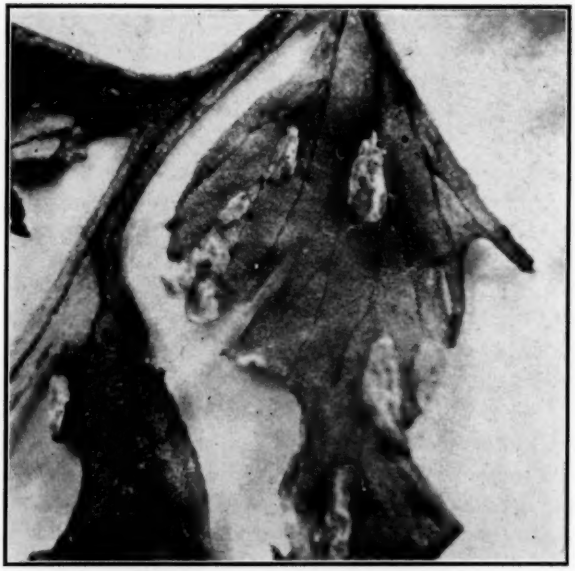

FIG. 3. Ascus-bearing lesions of *Taphrina Cystopteridis* on leaves of *Cystopteris fragilis* (L.) Bernh. × 10.

scribed species on ferns. Species of a somewhat comparable size are as follows:

Taphrina cornu-cervi. Asci 24 $\mu \times$ 5–6 μ, stalk cells 4–6 $\mu \times$ 2–4 μ.

Taphrina Struthiopteridis. Asci 16–28 $\mu \times$ 4–6 μ, stalk cells 4–7 $\mu \times$ 3–4 μ.

Taphrina fusca. Asci 20–24 $\mu \times$ 5–7 μ, stalk cells "long, cylindric." (23–33 μ. See above.)

The first two of these species have stalk cells much shorter than the form on *Cystopteris,* the third has a longer one. All three produce host lesions different from the *Cystopteris-Taphrina: T. cornu-cervi* causing long, horn-like outgrowths; *T. fusca,* fleshy galls resembling those on *Cystopteris* but larger; and *T. Struthiopteridis,* yellow spots, with no thickening of leaf tissues.

A fourth species, *Taphrina Vestergrenii* Giesenhag. on *Dryopteris filix mas* Schott is described by Giesenhagen (**4**) as having asci 25 × 6 μ, "stalk cells truncate." Jankowska (**5**) gives dimensions as follows: asci 24–34 μ × 5–7 μ, stalk cells 12–21 μ, spores 7 × 3 μ, and says that the stalk cell may taper to a pointed lower end. Two specimens of this fungus have been examined by the writer. The first (University of California Herbarium 211822, Feldberg, Baden, Aug. 1903, G. Lagerheim) showed asci 26–43 μ × 7–10 μ, stalk cells 10–23 μ × 4–5 μ, spores 3.5–5 μ × 2.5–4 μ. Many of the asci were very irregular in contour. In the second specimen (Rehm: Ascomyceten, No. *1412,* Abro, near Osel, Baltic Russia, July, 1899, T. Vestergren) the asci were 23–36 μ × 6–8 μ, stalk cells 12–17 μ × 4–6 μ, spores 4.5–5.5 μ × 3–3.5 μ, and long tapering stalk cells with pointed ends were observed. (In two packets examined of Sydow, Mycotheca Germanica No. *978,* the material was quite worthless, being overmature with no asci present.) It is thus seen *Taphrina Vestergrenii* is more variable than would appear from Giesenhagen's original description, and it does not show much resemblance to the fungus on *Cystopteris.* The galls caused by the two fungi are similar, except that those caused by *T. Vestergrenii* are much larger.

ONOCLEA SENSIBILIS L. Sensitive Fern.

9. *Taphrina Hiratsukae* Nishida.

This fungus is known from three collections in North America. A specimen in the herbarium of John Dearness was collected at Hudson Falls, New York, August 7, 1919. A second (Herbarium of L. O. Overholts No. *9659*) was collected at Houserville, Pennsylvania, August 10, 1921, by C. R. Orton and W. A. McCubbin, a third (Herbarium of University of Toronto, No.

2879) at Wilcox Lake, Ontario, August 4, 1930, by H. S. Jackson. The fungus was described in 1926 by Overholts (**8**) but not named.

Taphrina Hiratsukae causes on the leaves of its host elongate or irregular rusty-yellow spots, with no thickening or distortion of leaf-tissues. The hymenium is hypophyllous. Asci in the American specimens are 13–30 $\mu \times$ 4–7 μ, stalk cells 5–7 $\mu \times$ 4–5 μ, spores 2–6 $\mu \times$ 2–2.5 μ (FIG. 2, *G*). One Japanese specimen has been examined, collected at Morioka, Prefecture of Iwate, July 22, 1934, by K. Togashi (loaned to the writer from the Herbarium of The New York Botanical Garden). In this the asci are 20–30 $\mu \times$ 5–7 μ, stalk cells 5–7 $\mu \times$ 4–5 μ, spores 3.5–4 $\mu \times$ 2–2.5 μ (FIG. 2, *G*). The asci from the Japanese specimen are on the average somewhat longer and more slender than in the American material, but this difference might disappear if enough material of both forms were examined. As originally described by Nishida (**7**) *T. Hiratsukae* has asci 18–30 $\mu \times$ 4–6 μ, stalk cells 7–8 $\mu \times$ 3–4 μ, spores 4–5 $\mu \times$ 2–3 μ.

PTERETIS NODULOSA (Michx.) Nieuwl. (*Struthiopteris germanica* Beck.) Ostrich Fern.

10. *Taphrina Struthiopteridis* Nishida.

This fungus has been collected from three localities in Wisconsin: Jump River, August 3, 1920; Weyerhaueser, July 27, 1925; Crinitz, August 24, 1931; by J. J. Davis. It causes yellow to brown spots on leaves, with no thickening of the tissues. The spots are usually bordered by veins, though one spot may include more than one vein-islet. The asci are hypophyllous, 17–23 $\mu \times$ 5–6 μ. Stalk cells are 5–10 $\mu \times$ 3–5 μ, spores 4–5 $\mu \times$ 2–3 μ (FIG. 2, *K*). According to Small the Japanese Ostrich Fern (*Struthiopteris germanica* Willd.) is distinct from the American (*S. germanica* Beck), but the fungi on the two ferns seem to be identical. The Japanese fungus is described as having asci 16–28 $\mu \times$ 4–6 μ, stalk cells 4–7 $\mu \times$ 3–4 μ.

As indicated earlier in this paper, the morphological similarity between this fungus and *Taphrina Hiratsukae* is striking. It may be questioned whether the two species are well distinguished.

SUMMARY

Ten species of *Taphrina* are known on American ferns, as follows:

1. *Taphrina lutescens* Rostr. on *Thelypteris thelypteris* (L.) Nieuwl. Minnesota (?). Maine, New York.

2. *Taphrina californica* on *Dryopteris arguta* (Kaulf.) Wats. California.

3. *Taphrina gracilis* on *Dryopteris marginalis* (L.) A. Gray. New York.

4. *Taphrina fusca* Giesenhag., on *Dryopteris spinulosa* (Muell.) Kuntze (new host), New Brunswick, New Hampshire, West Virginia, Vermont.

5. *Taphrina filicina* Rostr. on *Dryopteris spinulosa* (Muell.) Kuntze. Vicinity of Ithaca, New York.

6. *Taphrina Polystichi* on *Polystichum acrostichoides* (Michx.) Schott. Eastern North America.

7. *Taphrina Faulliana* on *Polystichum munitum* (Kaulf.) Presl. Rhododendron, Oregon.

8. *Taphrina Cystopteridis* on *Cystopteris fragilis* (L.) Bernh. Indiana, Kansas, Wisconsin.

9. *Taphrina Hiratsukae* Nishida, on *Onoclea sensibilis* L. Ontario, New York, Pennsylvania.

10. *Taphrina Struthiopteridis* Nishida, on *Pteretis nodulosa* (Michx.) Nieuwl. Wisconsin.

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MYCOLOGICAL NOTES. II

C. L. SHEAR

(WITH 1 FIGURE)

6. NUMMULARIA Tul. Sel. Fung. Carp. **2**: 41 (Trans. 39). *pl. 5.* 1863.

Among the distinctive characters of this genus, the author mentions especially the membranous perithecia lying nearly free in the locules of the stroma, and says the characters of the genus were taken from *Hypoxylon nummularium* Bull., and *Sphaeria discreta* Schw., " which should be considered the types of the genus." As he specifies two species as types, a choice must be made for nomenclatorial purposes.

The first species described is *N. Bulliardi* based on *Hypoxylon nummularium* Bull. It is clear from this that he took the generic name from Bulliard's specific name, and as this is the first species described and also represents the group for which *Nummularia,* when treated as a separate genus, has most generally been used by subsequent writers, it would seem in the interests of uniformity and stability of generic names to apply the name to *N. Bulliardi* and its congeneric species. If we accept the opinion that this species has no characters sufficient to separate it from *Hypoxylon,* it would be included as a synonym of that genus.

Miller (Trans. Brit. Myc. Soc. **17**: 131. 1932) has proposed to take as the type *Nummularia discreta* (Schw.) Tul. and include *Bolinia* (Nits.) Sacc., 1882 as a synonym. Of course *N. discreta* is usually separated from *Hypoxylon,* but is very clearly closely related to it. Saccardo referred *N. discreta* to *Anthostoma* under the name *A. discincolum* (Schw.), but this could scarcely be considered congeneric with any of the species originally included in *Anthostoma* by its author. The perithecia in *N. Bulliardi* are in a single series and a similar epistromatic conidial layer precedes the formation of the entostromatic perithecia in both species. It therefore seems that a natural grouping of species would require

these two and their near relatives to be included in the same genus whether it be *Nummularia* or *Hypoxylon*. Miller, however (l.c. 132), has separated the species placing *N. Bulliardi* in *Hypoxylon*, and taking *N. discreta* as the type of the emended genus *Nummularia*, including *Bolinia* as a synonym. The type of *Bolinia, B. tubulina* (Alb. & Schw.) Sacc., however, seems quite different from *N. discreta* in stromatic and perithecial characters and paraphyses. Furthermore no conidial stage is known in *Bolinia*.

As pointed out by Miller, *Nummularia* Tul. under the international rules, unless conserved, would have to be recognized by some other name, on account of the previous homonym, *Numularia* Gilib. 1781. If another name is to be substituted, three have already been proposed, *Biscognauxia* O. Kuntze, Rev. Gen. Pl. **2**: 398, 1891, type *B. Bulliardi* (Tul.) O. K.; *Kommamyce* Nieuwland, Am. Mdl. Nat. **4**: 375, 1916, type *K. Bulliardi* (Tul.) Nieuw.; and *Numulariola* House, Ann. Rep. N. Y. State Bot. **1924**: 49, 1925. No type specified, but 4 species included, *N. atropunctata, discreta, nummularia,* and *repanda,* in the order given. These generic names, however, are all typonyms of *Nummularia,* as applied to *N. Bulliardi,* and not as applied to *N. discreta.*

In our opinion the most natural and convenient mode of treatment would be to conserve *Nummularia* with *N. Bulliardi* as type and include *N. discreta* and *N. repanda,* as these species in their life histories and morphology show closer relationship to *N. Bulliardi* than to *Anthostoma, Lopadostoma, Bolinia* or *Camarops.*

7. ANTHOSTOMA Nits. Pyren. Germ. 110. 1867.

Nitschke's first species under this genus is *A. decipiens* (D.C.). He divides the genus in two sections; first, *Anthostoma* proper, and second, *Lopadostoma.* The first group he says has a diatrypoid stroma immersed in the wood or thick bark. *A. decipiens* does not really have a typical diatrypoid stroma, but rather eutypelloid. This species shows close relation to *Eutypa* and *Eutypella* in morphology and life history and would better be placed in that group. The stroma consists of the slightly modified tissue of the bark or wood and the perithecia have rather thick, more or less divergent, exserted, definitely stellate-sulcate ostioles. This is

the character to which the name refers—*Anthos*—meaning "flowerlike." The other species in this group, *A. hiascens* Fries, is rare and somewhat doubtful, but it is described as having the same character of stroma and ostioles as the first.

The life history of *A. decipiens* is described and illustrated by Tulasne, Sel. Fung. Carp. **2**: 59 (56–60 English trans.) *pl. 8, f. 1–9,* under the name *Eutypa decipiens.* He shows a loculate entostromatic pycnidial stage producing allantoid, hyaline spores. He also says that he sometimes finds a silky brown villous growth on the surface of the young stromata, but has never seen any conidia on it. Winter, Die Pilze (p. 757), says this brown growth of hyphae produces conidia which are hyaline, cylindrical, somewhat curved, pointed and one-celled. Little is known about the life history of the other species usually included.

In *A. melanotes* (Berk. & Br.) Sacc., described also as *A. Schmidti* (Awd.) Nits., the perithecia are immersed, gregarious or somewhat scattered, with the surface of the wood more or less blackened, forming an eutypoid stroma very similar to *Endoxyla,* but with the spores not allantoid. In none of these species is there a typical stroma as in *Diatrype.* Only the blackened surface of the host or a blackened circumscribing line in the bark or wood is present.

A. melanotes should be taken as the type of the genus instead of *A. decipiens* which was used in Clements and Shear, The Genera of Fungi, as this would place the application of the name in accord with prevailing usage, as followed by Saccardo, Winter, Traverso, Petrak, and others, and thus avoid confusion.

Petrak, Ann. Myc. **21**: 253–255. 1923, discusses this genus and says it is not closely related to the Valsaceae on account of the differences in the structure of the perithecial nucleus and the spores which resemble those of the Xylariaceae. Closely related genera are *Creosphaeria, Leptomassaria* and *Anthostomella.* Between *Anthostomella* and *Anthostoma,* with many transition forms, he finds no sharp distinction. According to Petrak *Anthostoma* includes the following "Grundtypen":

I. *Anthostoma* in the strict sense, which has the stroma effuse, eutypoid, but very poorly developed or almost lacking. This he divided into two sections. *Section 1. Endoxyla* which includes

the forms usually referred to the genus *Endoxyla* Fuckel. The perithecia are small, scattered, imbedded with no stroma. The type has distinctly allantoid spores. *Section 2. Euanthostoma.* Stroma eutypoid, very weakly developed, sometimes almost lacking, regarded as typical of the genus. Ostioles short, rarely somewhat elongate and only slightly spreading. This would include *A. Schmidti* Nits. (*A. melanotes* (Berk. & Br.) Sacc.) which we take as the type of *Anthostoma.* Winter also has *A. melanotes* first in his treatment of the genus.

II. *Lopadostoma* Nits. Stroma valsoid, mostly well developed and distinct. Petrak divides this into two sections, without names. *Section 1.* Stroma typically euvalsoid, composed of the scarcely modified substance of the substratum, containing a few perithecia more or less circularly arranged with ostioles united into a small erumpent disk. *A. turgidum* (Pers.) Nits. given as typical has a small erumpent disk. *Section 2.* Stroma more developed, eutypelloid or diatrypelloid with enclosing crust or a black circumscribing line as in *A. microsporum* Karst. Perithecia closely arranged with elongate, separate or united ostioles. He says most *Lopadostoma* species show certain special peculiarities in the structure of the stroma. In the euvalsoid section as typified by *A. turgidum* an almost typical valsoid stroma occurs. In *A. gastrinum,* the type of *Lopadostoma* (Nits.) Traverso, the stromata are larger and bounded according to Petrak by a black outer crust having the ostioles, when the fungus is in the bark, very closely pressed together and typically eutypelloid. When growing on naked wood, however, the stromata are more or less verrucose and diatrypelloid. In such cases ostioles are erect, straight and break out over the whole surface of the stroma. In *A. microsporum* Karst., he says the stromata are rarely separated, but usually very closely crowded and form a more or less widespread crust in which the separate stromata, however, can be rather plainly recognized. The outer crust consists of thin, dark brown tissue and the perithecial walls in structure and consistency show great similarity to those of the *Valsasiae.* He does not regard *Lopadostoma* as a natural genus, but says that in the structure of the perithecial nucleus and the spores, the species mentioned are all more or less closely related, though different.

His observations as to the characters of these species agree with ours, but we believe it is more natural and convenient to retain *Lopadostoma* as a genus for the present at least with *L. gastrinum* as the type. All sorts of intermediate forms are found between valsoid, eutypoid and diatrypelloid stromata. The character of the stroma in this group as in many others is very variable and unsatisfactory as a generic character.

8. CAMAROPS, PHAEOSPERMA, AND BOLINIA

CAMAROPS Karst. Myc. Fenn. **2**: 6. 1873

This genus was based on the monotype, *C. hypoxyloides,* Karst. l.c., p. 53. An examination of Karsten's type specimen kindly loaned me by Doctor Lindberg of Helsingfors shows that in color, consistency and other characters of the stromata and perithecia this is very similar to the type of *Bolinia, B. tubulina* (Alb. & Schw.) Sacc. The principal difference is in the longer, tubular, or more or less angular perithecia, and the more regular stromatic disk and evenly distributed ostioles in *Camarops.* A careful study of various specimens of *C. hypoxyloides* from widely separated localities shows considerable variation in the stromatic and perithecial characters of this species.

Karsten's species was described and illustrated by Engelke in Ann. Myc. **7**: 176. *f. 1–8.* 1909, under the mistaken name of *Nummularia lutea,* as von Höhnel has already pointed out. This fungus is very similar in the character of the stromata and especially in the asci, paraphyses and spores to *Bolinia tubulina.* In fact, the spores of the two can scarcely be distinguished. The chief difference is in the perithecia, which in Karsten's type are narrower, tubular, or more or less angular by compression and closely packed in a single series with little or no neck. The perithecia are easily separable and are covered on the outside with the same pale-yellowish pulverulence as in *Bolinia.* The stromata vary in thickness, and consequently in length of perithecia, which are from 3 to 8 mm. long (3–4 in the type).

In our opinion the following species with their synonyms are congeneric and should be referred to *Camarops:*

CAMAROPS POLYSPERMA (Mont.) Miller.

Hypoxylon polyspermum Mont. in de la Sagra, Hist. Nat. Cuba Bot. p. 345. 1842.

Camarops hypoxyloides Karst. Myc. Fenn. **2**: 53. 1873.

Hypoxylon cylindrophorum Ellis. & Ev. Bull. Lab. Nat. Hist. Univ. Iowa **2**: 407. 1893.

Nummularia ustulinoides P. Henn. Hedwigia **36**: 227. 1897. Sec. Theissen, Ann. Myc. **7**: 158. 1909.

Solenoplea microspora Starb. Bih. Sv. Vet. Akad. Handl. 27, Afd. 3, no. 1: 13, *f. 13–15.* 1901.

Specimens examined: Karsten, type on *Ulmus,* Finland, Oct. 1872, spores 5–6 × 2–3 μ; Mont. type (as *Hypoxylon polyspermum*), Cuba, spores 4–5 × 2.5–3 μ; Otth. ined. type as *Hypoxylon pulvinatum* Otth., No. *132* on *Polyporus* in Herb. Nits. Switz., perithecia shorter than in type, spores 4–6.5 × 3–4 μ; Ellis & Ev. type, as *Hypoxylon cylindrophorum,* C. L. Smith, Mic. Fungi Nicaragua, No. *82,* spores 5–6 × 2.5–3 μ, epistroma a little thicker than in type species; Spec. Herb. Langlois as *Nummularia* sp., La., apparently on oak, Oct. 12, 1897, spores 4–6 × 2.5–3; Mason, E. W. as *Camarops polyspermum* (Mont.) Miller, No. *105*—England; Overholts & Siggers, Nov. 5, no. *484* on *Gleditsia,* Ferraday, La., 1931, spores 4–6 × 3–4. This is an intermediate form at first referred to *C. tubulina.* The perithecia are less regular and the epistroma somewhat thicker than in typical *C. hypoxyloides.*

C. tubulina (Alb. & Schw.) comb. nov.[1]

Sphaeria tubulina Alb. & Schw. Consp. Fung. 6. *pl. 4, f. 4.* 1805.

[1] Names ending in *-ops* may according to Sprague (Kew Bull. Misc. Inf. **1935**: 554. 1935) may be either masculine, feminine or neuter, and the gender indicated by the author should be used. Karsten's type *hypoxyloides* may be either masculine or feminine. The feminine form has been chosen as this accords with the usage in another genus of fungi having the same ending, *i.e., Melanops.*

Sphaeria lutea Alb. & Schw. Consp. Fung. 10. *pl. 1, f. 1.* 1805.

Hypoxylon tubulinum (Alb. & Schw.) Fries, Summa Veg. Scand. 383. 1849.

Bolinia tubulina (Nits.) Sacc., Syll. Fung. **1**: 352. 1882.

Nummularia tubulina (Alb. & Schw.) Miller, Trans. Brit. Myc. Soc. **17**: 134. 1932.

Hypoxylon atroviride Ellis & Ev. Proc. Acad. Phila. **1894**: 346. 1895.

Hypoxylon ohiense Ellis & Ev. N. Am. Pyren. 648. 1892.

Specimens examined: Fries, as *Sphaeria tubulina* Alb. & Schw., Scler. Suec. No. *341,* Herb. Strasburg, also Herb. Greville, Edinburg; Ellis & Ev. Type, as *Hypoxylon atroviride* Ellis & Ev. Nuttall No. *275,* W. Va.; Ellis & Ev. Type as *Hypoxylon ohiense* Ellis & Ev. Morgan No. *965,* Ohio. Also same number from Herb. Morgan and No. *883* Morgan in Ellis Herb.; Plowright as *Hypoxylon luteum* Fries, No. *16* Sphaer. Brit. Exs. Herb. Ellis; Alb. & Schw. as *Sphaeria lutea* Alb. & Schw., part of original collection in Herb. Schw., and in Herb. Michener.

C. tubulina var. **gigas** (Phill. & Plow.) comb. nov.

Nummularia gigas Phill. & Plow. Grevillea **8**: 106. *pl. 130, f. 3.* 1880.

The description and illustration of this plant as indicated by Miller, Trans. Brit. Myc. Soc. **17**: 134. 1932, suggests that it is the same as *Nummularia lutea* (Alb. & Schw.) Nits.; but he says he saw no authentic specimen. The type is supposed to be at the British Museum, but when I was there in 1930 it could not be located. There is, however, at Kew a specimen in Herb. M. C. Cooke which is undoubtedly a part of the original gathering. It is labelled "*Hypoxylon luteum* Fr.? on birch, Oct., 1876, Ringstead C. B. P.," in Plowright's hand. This agrees with the original description, locality and date. It is this specimen apparently upon which Cooke, Grevillea **12**: 5. 1883, based his spore measurements. He says they certainly do not

FIG. 1. *Camarops tubulina* (Alb. & Schw.) Shear (*Num mularia lutea* (Alb. & Schw.) Nits.) on decaying *Buxus sempervirens* showing variations in form, size, and location of stromata. Natural size.

exceed .006–.007 × .003 mm. (6–7 × 3μ). Our measurements from this specimen show spores 5.5–7 × 3.5–5 μ, mostly 6 × 4 μ, which are slightly greater than those in the type of *S. lutea* Alb. & Schw., which are mostly 5 × 3 μ. The original measurements of 10–12 × 8–10 μ as given by Phillips and Plowright must be considered erroneous, unless the true type can be found and shown to have the larger spores. The spores in the specimen cited are somewhat darker colored than usual and more frequently ovoid to subglobose. We would regard it for the present at least as a variety of *Camarops tubulina.*

C. ferruginea (Nits.) comb. nov.

Anthostoma ferrugineum Nits. Pyren. Germ. 118. 1867.
Sphaeria rarissima ined. in Herb. Duby at Strasburg, spores 12–15 × 4 μ.

Specimens examined: Nitschke, type on willow, Nienberge Germ.; Shear, No. *5815* on *Hamamelis,* Sawkill Valley, Catskill Mts., N. Y.

C. microspora (Karst.) comb. nov.[2]

Phaeosperma helvetica Nits. in Fuckel, Symb. Myc. 224. 1869.
Fuckelia helvetica (Nits.) Fuckel, Symb. Myc. Nachtr. **2**: 40. 1873.
Phaeosperma microspora Karst. Myc. Fenn. **2**: 53. 1873.
Anthostoma microsporum Karst. Fung. Fenn. Exs. *860*; Acta Soc. Faun. Fl. Fenn. **2**, no. 6: 75. 1885.

Specimens examined: On *Ulmus,* Macoun, Canada, No. *284*; on *Ulmus,* D. V. Baxter, Skagway, Alaska; on *Ulmus,* C. Morthier, Neuchatel, Switzerland; on *Ulmus,* O. Jaap, Fungi Sel. Exs. No. *684,* Schleswig-Holstein, Germany; on *Ulmus,* A. S. Rhoads, No. *16624,* Idaho; on *Ulmus,* Wehmeyer, Copeland,? No number; on *Ulmus,* C. H. Peck, West Albany, N. Y.; on *Ulmus,* Karsten, Finland.

[2] The name *microspora* is used rather than the older *helvetica* because it is better known and more generally used.

Camarops peltata (Lloyd) comb. nov.

Solenoplea peltata Lloyd Myc. Writ. **7**: 1354, *f. 3173–3175.* 1925.

According to Lloyd's type collected by C. M. Tucker in Puerto Rico, and a specimen of the same gathering received from Tucker, this is a good *Camarops.* The illustration cited shows well the characters of the species. The regular peltate form of the stroma with its thick base separates it readily from the other species.

The life histories of these species should be studied to determine whether any conidial forms exist. This would throw further light upon their relationships.

PHAEOSPERMA. Nits., Fuckel, Symb. Myc. 224. 1869.

The monotype of this genus, *P. helvetica,* is according to Karsten, Myc. Fenn. **2**: 50. 1873, the same as his *Anthostoma microsporum,* and he changes the name to *P. microspora* Karst. Later Fuckel, 2nd Nachtrag, p. 40, put this in *Fuckelia* as *F. helvetica.* We have been able to verify Karsten's statement regarding these species by comparison of a part of Fuckel's type collection from Mortier's Herb. with Karsten's type specimen from Finland. This species has a distinct and well defined stroma of a brown, coriaceous character. The perithecia are closer and much more regularly arranged in the stroma, and of a thinner and more fragile submembranaceous character than in *Lopadostoma.* The ascospores, however, have a similar hyaline envelope. Karsten (l.c.) also includes in *Phaeosperma, P. fennicum* Karst, and *P. foedans Karst.* We have not seen these species. After careful study of considerable material of the type species, I find that it resembles in many respects *Camarops,* though it has usually been referred to *Anthostoma* or *Lopadostoma.* The character and arrangement of the perithecia, as well as the agglutinated paraphyses and hyaline envelope about the spores agree very closely with *Camarops.* The outward form of the stroma is somewhat like *Lopadostoma;* but as there is no indication at present that this species has any conidial stage, we consider it more closely related to *Camarops* than to *Lopadostoma* and would refer it to that genus, making *Phaeosperma* Nits. a synonym of *Camarops.* The name

Phaeosperma (Sacc.) Trav. Fl. Ital. Crypt. **2**: 292. 1906, was applied to an entirely different group of species, having a eutypoid pseudostroma with one septate, brown spores, typified by *P. Saccardiana* (Speg.) Trav.

BOLINIA (Nits.) Sacc. 1882

This was first segregated by Nitschke, Pyren. Germ. 26, 1867, as a section of *Hypoxylon* with the single species *H. tubulinum* (Alb. & Schw.) Fries, and later raised to generic rank by Saccardo, Syll. Fung. **1**: 352. 1882, with the same type. This fungus is apparently uncommon in Europe, and very few specimens have been recorded or preserved in herbaria. No type or authentic specimens of this species are known to exist at present; but specimens distributed by Fries as No. *341,* Scler. Suec. Exs. under this name agree with the original description and illustration of Albertini and Schweinitz, Consp. Fung., 6. *pl. 4, f. 4.* 1805, and I think should be accepted in lieu of the original, as a basis for the identification of the species. The specimens of Fries we have examined are characterized by having a more or less superficial, effuse stroma with entirely immersed perithecia, irregularly arranged in two or more series with long necks and umbilicate ostioles. The epistroma is thin and somewhat carbonous, at first a dirty brown, frequently becoming dark colored; the final color being due to the adhesion of a layer of expelled ascospores which have a hyaline gelatinous envelope and adhere closely to the surface when expelled, or remain in small masses about the ostioles, unless washed away. The asci are cylindrical, more or less long pedicillate, 8-spored; the spores obliquely monostichous, ovate to oblong, straight, unicellular, yellowish brown, varying from 4–6 × 2.5–4 μ. The majority of the spores are 5 × 3 μ. Nitschke l.c. has an excellent detailed description of this species based on a specimen from Kunze's collection and one from Sweden. Whether the latter was Fries' Scler. Suec. No. *341* or not is not stated.

Albertini and Schweinitz l.c., 10, *pl. 1* (*f. 1*), described as a new species, *Sphaeria lutea.* This was placed in *Hypoxylon* by Berkeley, Outl. Brit. Fung. 386. 1860, and referred by Nitschke to *Nummularia* l.c. 59. This species as described and illustrated

by the authors seems remarkably like their *Sphaeria tubulina.* Fortunately, there is a portion of the type of *S. lutea* in Schweinitz' herbarium, and another from Schweinitz in Michener's herbarium. A comparison of these specimens with Fries' specimen of *B. tubulina* shows their great similarity, and indicates that there is probably no specific difference between the two. The spores are practically identical in both and the character of the stromata and perithecia the same. The only noticeable difference is in the thickness of the stromata and the arrangement and shape of the perithecia, which seem to be subglobose, rather than pyriform in *B. lutea.* We had an opportunity in 1930 through the kindness of Mr. E. W. Mason to visit a locality in England where *S. lutea* is rather abundant on dead and decaying box plants, *Buxus sempervirens.* Numerous specimens were taken showing the wide range of variation in the size, form, and situation of the stromata. All intermediate forms and conditions of stromata and perithecia connecting the two species as illustrated by Albertini and Schweinitz were found. These are illustrated in figure 1.

From a study of these specimens and by comparison with other material which has been found in Europe and America we are convinced that we are dealing with a single very variable species. The asci and spores in all are practically the same. The perithecia show a wide range of variation in size, shape, and length of necks. They are irregularly packed together and separate rather easily when the stroma is broken, and the outside of the perithecial wall is covered with a thin yellowish pulverulence. Nitschke referred *S. lutea* to the genus *Nummularia,* and did not suggest any relationship to *S. tubulina.* He apparently did not have a good specimen of *B. lutea.* In fact, he says that he studied "eines freulich sehr wenig instructionen exemplar" which was found in Kunze's collection, and probably came from the discoverers of the species.

In this connection it is interesting to note that Currey, Act. Soc. Linn. Lond. **22**: 268, *pl. 56.* 1858, described and illustrated these two plants. The specimen called *S. lutea* was determined by Berkeley and *S. tubulina* was from Fries, Scler. Suec. No. *341.* As a result of his study he says he could not distinguish the two species. We have examined other European specimens as well as

American and must conclude that so far as present available material is concerned it all belongs to one variable species, which should take the specific name *tubulina,* as this has page priority over *lutea.*

After a careful study and comparison of the types so far as extant, and other specimens, I can only conclude that there are no differences of generic value between *Camarops, Bolinia* and *Solenoplea.* In fact the similarity in stromata, perithecia, paraphyses, and spores might almost lead one to regard them as one polymorphic species, if constant differences of any importance were insisted on.

A remarkable character of all specimens examined is the presence of peculiar irregular filaments, paraphyses or periphises, embedded in a hyaline mucilaginous matrix. These hyphae show intermittent sections of homogeneous protoplasm separated by apparently shrunken empty sections not easily demonstrated except in very thin, crushed mounts with an oil immersion objective.

Miller, Trans. Brit. Myc. Soc. **17**: 132. 1932, gives *Bolinia* as a synonym of *Nummularia* and l.c. 134 puts both *B. tubulina* and *B. lutea* in that genus. It does not seem proper, however, to refer these plants to *Nummularia,* whether the type of that genus be considered *N. discreta,* as Miller prefers, or *N. Bulliardi* as we take it. The lack of an epistromatic conidial layer and of a membranous inner perithecium, as well as the differences in paraphyses in *Bolinia* seem to be sufficient for generic separation. Further discussion of these and other species is found under *Camarops* to which they are referred.

9. LOPADOSTOMA, FUCKELIA

Lopadostoma (Nits.) Trav. 1905. This name was first used for a subgenus of *Anthostoma* by Nitschke, Pyren. Germ. 121. 1867, with the monotype *A. turgidum* Pers., and was raised to generic rank by Traverso, Flo. Ital. Crypt. **2**: 169. 1905, who added another species, *L. gastrinum* (Fries) Trav.

Nitschke says it is characterized by a valsoid stroma, but neither of the above species has a truly valsoid stroma as is well illustrated by Traverso l.c., *f. 32.* The ostioles are united in a patellate disk which varies greatly in size according to the number of perithecia in the pseudostroma. The smaller groups of perithecia are some-

what valsoid-pustulate and the larger pulvinate and diatrypoid in shape. The perithecia are sometimes arranged in a single series or in the larger stromata they are irregularly biseriate, as shown by Traverso, l.c. *f. 32* and by specimens of *L. gastrinum* in Plowright's Sphaer. Brit. Exs. *24*. This genus has some similarity in stroma to *Nummularia discreta* and *N. repanda,* but differs in having a very different conidial stage and in its mode of development.

The conidial layer in *N. discreta* and *N. Bulliardi* is epistromatic and evidently formed in much the same manner in both. Apparently no such conidial formation is found in *Lopadostoma.* Tulasne's account of *L. gastrinum* (*Melogramma gastrinum*) in Sel. Fung. Carp. **2**: *84*, shows that the conidial form is a *Cytospora.*

Fuckelia Nits. in Fuckel, Symb. Myc. 224. 1869. Two species were referred to this genus as originally described, *F. amoena,* Nits., and *F. rhenana* Fuckel, and in Nachtrag **1**: 314. 1871, Fückel added *F. gastrina* (Fries) Fuckel. According to von Höhnel, Ann. Myc. **16**: 122. 1918, the first two names are synonyms and the plants have the same general character and structure throughout as *Anthostoma gastrinum* which was included by Fückel, as cited. Therefore *Fuckelia* is a synonym of *Lopadostoma* of which *L. gastrinum* (Fries) Trav. is the type. This is confirmed by our examination of a specimen of *F. rhenana* Fuckel in his Fung. Rhen. Exs. *2053*.

No conidial stage of the type species is known at present. The name *Fuckelia* though older than *Lopadostoma* is untenable as there is an earlier genus of the same name by Bonorden, Abh. Geb. Myk. **1**: 135. 1864.

The type *F. amoena* being transferred to *Lopadostoma* would become **L. amoenum** (Nits.) Shear comb. nov.

Slides or specimens cited are deposited in the Mycological Collections of the Bureau of Plant Industry unless otherwise indicated.

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI. XXIX CHLOROSCYPHA

FRED J. SEAVER

(WITH 1 FIGURE)

Recently the writer received a fine collection of an inoperculate cup-fungus from Dr. F. A. Wolf of North Carolina, which was referred to *Lachnella cedrina* (Cooke) Saccardo. Although a portion of the type material of this species is in our collection, the specimens are scant and rather immature, but so far as we can judge the material collected by Wolf is identical. The only other specimen under this name in our collection is one collected by Thaxter, but which is evidently misdetermined. Since this species seems to be of rare occurrence, we think it advisable to redescribe and illustrate it.

Saccardo placed this species in the genus *Lachnella.* It scarcely seems to fit here since the apothecia are not hairy, although they are clothed with a dark colored mycelium, the strands of which are vertically placed giving the margin a fimbriate effect. In fact, the position of the species is somewhat in doubt. It closely resembles species of *Chloroscypha,* as described by the writer, all of which occur on coniferous evergreens, usually on the foliage. The spores of other species of *Chloroscypha* are non-septate while in this species they are occasionally 1-septate. In spite of this fact they seem to fit here better than in any other known genus, and I therefore include it as a member of that genus. The description and synonymy is appended below.

Chloroscypha cedrina (Cooke) comb. nov.

Peziza cedrina Cooke, Bull. Buffalo Soc. Nat. Sci. **2**: 294. 1875.

Lachnella cedrina Sacc. Syll. Fung. **8**: 395. 1889.

Apothecia gregarious, sessile, reaching a diameter of 1 mm. and nearly as deep, black and vertically striated with dark my-

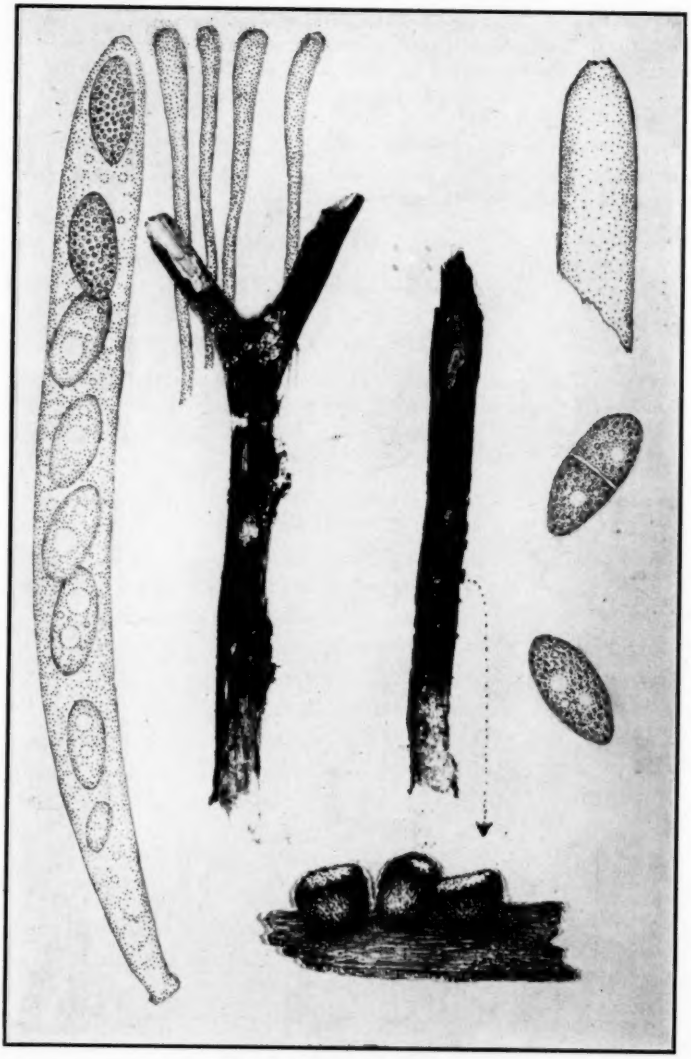

FIG. 1. *Chloroscypha cedrina.*

celium; hymenium dark; asci cylindric or subclavate, reaching a length of 140–160 μ and a diameter of 12–14 μ, 8-spored but some of the spores often immature; spores usually 1-seriate, ellipsoid with the ends slightly attenuated, densely filled with granules and oil-drops, usually simple but occasionally becoming taridly 1-septate; paraphyses slender about 3 μ in diameter below, strongly enlarged above where they reach a diameter of 5 μ, the ends strongly curved, becoming greenish-brown.

On branches of *Juniperus virginiana*.

TYPE LOCALITY: NEW YORK.

DISTRIBUTION: New York and North Carolina.

EXPLANATION OF FIGURE

Chloroscypha cedrina. Center, photograph of two branches of cedar with apothecia. Below, three apothecia very much enlarged. Left, drawing of ascus with spores and tips of paraphyses. Right, tip of ruptured ascus showing ascostome and below two mature spores.

NOTES AND BRIEF ARTICLES

Beverly Thomas Galloway

The sudden death on June 13 of Dr. Beverly T. Galloway at Washington, D. C., at the age of 75, is announced. Doctor Galloway will be remembered as a pioneer worker in America in mycology and plant pathology. He became the first and only Chief of the Division of Vegetable Pathology and Physiology of the Department of Agriculture in 1888, and in 1901 was instrumental in the formation of the present Bureau of Plant Industry. As the first chief of this Bureau he was responsible for its extraordinary development during the ensuing years. He was for a time Assistant Secretary of Agriculture during the first administration of Woodrow Wilson, and later Dean and Director of the New York State College of Agriculture at Ithaca. He resumed his connection with the Bureau of Plant Industry in 1916 as Senior Pathologist, later as Principal Pathologist, remaining until his retirement in 1933. In his early years before administrative duties overwhelmed him, he was actively interested in mycology and plant pathology as a lengthy list of publications will attest. While his interests tended strongly to the field of plant pathology, necessarily in the stage of knowledge existing at the time, mycology received its share of attention. One of his earliest papers dealt with the powdery mildews of Missouri, and there were later mycological papers in collaboration with J. B. Ellis, S. M. Tracy and others. During the years 1889 to 1894, Volumes 5 to 7 of the Journal of Mycology were published by the Division of Vegetable Pathology and Physiology under Doctor Galloway's direction. He was at all times deeply interested in the development of the Mycological Herbarium which he established as an integral part of his Division. It was through this interest that F. S. Earle, and later Mrs. Flora W. Patterson, were brought into the Division to give full attention to the upbuilding of the fungus collections.—J. A. Stevenson.

A RECENT COLLECTION OF THE ASCIGEROUS STAGE OF PHYSALOSPORA OBTUSA (SCHW.) COOKE IN MASSACHUSETTS

Based upon the examination of specimens in The Mycological Collections of the Bureau of Plant Industry, United States Department of Agriculture, N. E. Stevens in his recent article entitled, "Two Apple Black Rot Fungi in the United States" (MYCOLOGIA **25**: 536–548. 1933), reported the ascigerous stage of *Physalospora obtusa* (Schw.) Cooke [*P. Cydoniae* (Peck) Shear] only from the extreme southeastern section of Massachusetts. This fact is particularly interesting since it is the only collection of the perfect stage of *P. obtusa,* reported by him for New England where it is of economic importance. In this region the fungus not only forms cankers on the branches of apple trees but also causes a leaf spot and a rot of the fruits. Apparently, the ascigerous stage of this parasite either is rare or an intensive search has not been made for it in New England. Only recently, the late Doctor Clinton discussing the black rot disease of apple in his "Plant Pest Handbook for Connecticut, II, Diseases and Injuries (Conn. Agr. Exp. Sta. Bull. 348. 1934)," stated . . . "its asco stage found on the dead tissues has been determined as *Physalospora Cydoniae*. We have not yet found this stage. . . ."

In comparison to the one collection reported by Stevens for New England, he listed numerous collections of the perfect stage of this fungus in the states which are south of New England. In nearby New York, L. R. Hesler (Black Rot Leaf Spot, and Canker of Pomaceous Fruits, Cornell Univ. Agr. Exp. Sta. Bull. 379. 1916) reported that he found the perithecia of *Physalospora obtusa* on twigs of apple (*Pyrus malus* L.), of witch hazel (*Hamamelis virginiana* L.) and of white oak (*Quercus alba* L.).

Since there was reported only a single collection of the perfect stage of *Physalospora obtusa* by Stevens for New England, it seemed desirable to report a collection of the ascigerous stage of this fungus made by the writer in Amherst, Mass., in April of 1934. Furthermore, it is hoped that other collections will be reported so that the distribution of the perfect stage of this fungus will be completely known for New England.

For the purpose of conducting tests of certain fungicides at the Department of Botany of Massachusetts Experiment Station, Am-

herst, Mass., the writer made numerous collections of various fungi, including the black rot fungus of apple. Among these collections the writer found on a canker following fire blight of the Fall Pippin variety of apple, an ascomycete associated with the *Sphaeropsis* stage of the black rot fungus. This fungus was identified subsequently as the perfect stage of *Physalospora obtusa*. To check further on this determination, single ascospore and conidial isolations were made from these collections. Comparison of the cultures derived from these two different types of spores showed them to be identical. Furthermore, typical *Sphaeropsis* pycnidia, which yielded the *Sphaeropsis* type of spores, were produced in the cultures derived from the single ascospore isolations, thus proving without doubt the identification of the asciger-ous stage of this fungus.—THEODORE T. AYERS.

FLORA AGARICINA DANICA

The third volume of Dr. Lange's excellent work " Flora Agaricina Danica " appeared recently. Four genera, *Cortinarius, Pholiota, Inocybe* and *Hebeloma,* are treated.

One hundred and twenty-eight species and varieties are recognized in *Cortinarius.* All the species studied by Dr. Lange are described and illustrated, and only descriptions are given for those reported for Denmark by other investigators. The illustrations, as usual, are very well done. Lange has divided *Cortinarius* into *Leuco-cortinarius,* with one species, and *Cortinarii veri* which includes the remainder. The latter division represents the Friesian concept of the genus and the main Friesian divisions of it have been followed. *Armillaria bulbigera,* a hyaline spored agaric, is placed in *Leuco-cortinarius.* Twenty-eight species and varieties are included in *Phlegmacium.* Three new combinations are made: *C. sulphureus* (Kauff.) Lange (= *C. fulmineus* Fries var. *sulfureus* Kauffman); *C. sulfureus* var. *splendens* (Henry) Lange (= *C. splendens* Henry); and *C. nemorensis* (Fries) Lange (= *C. variicolor* var. *nemorensis* Fries). One undetermined species is included. Thirteen species are treated in *Myxacium.* The combination *C. pumilis* (Fries) Lange (= *C. collinitus* d. *pumilus* Fries) is made. Fourteen species and varieties are included in *Inoloma;* twenty-one in *Dermocybe;* twenty-three in *Telamonia*

and twenty-eight in *Hydrocybe*. The new combination *C. lucorum* (Fries) Lange (= *C. impenis* var. *lucorum* Fries) is made. This variety was recognized as a species by Kauffman and published as such in North American Flora **10**: 327. 1932. *C. melleo-pallens* (Fries) Lange (= *C. triformis* var. *melleo-pallens* Fries) is another new combination.

The genus *Pholiota* is divided into three subgenera, *Phaeolepiota, Rozites* and *Eu-pholiota*. One species, *P. Vahlii* is included in *Phaeolepiota*. This species is generally known in Europe and America as *Pholiota aurea* or *Phaeolepiota aurea*.

One species *P. caperata* is included in *Rozites*. Twenty-nine species and varieties are included in *Eu-pholiota*. One new species, *Pholiota intermedia*, is described. The choice of this name is unfortunate since it has already been used twice in the genus. Singer was the first to use it (Bei. Bot. Centrbl. Abt. **46**[2]: 107. 1929). I employed it for another species (Smith, Ann. Myc. **32**: 479. 1934) but later substituted the name *P. septentrionalis* (Mycologia **27**: 227. 1935). A new variety, *P. pumila* var. *subferruginea* Møller & Lange is described. New combinations are as follows: *P. aurivella* var. *cerifera* (Karst.) Lange (= *P. cerifera* Karst.); *P. brunneola* (Fries) Lange (= *P. ombrophila* var. *brunneola* Fries); *P. filaris* (Fries) Lange (= *P. togularis* var. *filaris* Fries). It is to be noted that the combination *P. filaris* (Fries) Peck was made by Peck in 1908 and recognized by Overholts, Ann. Mo. Bot. Gard. **14**: 116. 1927.

Inocybe is divided into *Eu-inocybe* with smooth spored and *Clypeus* with rough spored species. Forty-one species and varieties in *Eu-inocybe* are recognized. The new name *I. corydalina* var. *albido-pallens* Lange is proposed for the variety previously referred to *I. albidula* Britz sensu Saccardo. The new combination *I. Bongardii* var. *cervicolor* (Pers.) Lange is proposed for *I. cervicolor* (Pers.) Fries. Eighteen species are included in the rough spored group.

In *Hebeloma* five species are grouped in section A, *Indusiata*, including a new species, *H. pumilum* Lange, and eight in section B, *Denudata*, including *H. pusillum* Lange which is also new.—ALEXANDER H. SMITH.